THURSDAY, FEBRUARY 13, 1872

THE "THUNDERER" EXPLOSION

NOW that the Committee appointed to inquire into the cause of the bursting of one of the 38-ton guns on board the *Thunderer* have made known the substance of their report, it is no longer necessary to suspend judgment and withhold comment for fear of prejudicing the case. The abstract only of the report of the Committee, which has reached us by telegram, states that the explosion was due to a cause, which, as far as we are aware, was not anticipated by any one of the numerous writers who have made suggestions or advanced theories on the subject. They simply report that the gun having missed fire when loaded with the battering charge, was again loaded with a full charge, and fired with both of the charges in the gun at the same time. We are bound to assume that conclusive evidence of this extraordinary occurrence has been obtained by the Committee, or the statement would be simply incredible. Cases are recorded in volley-firing of a soldier loading charge after charge into his musket or rifle in the days of muzzle-loaders, being unaware that the first had missed fire until the violent explosion, and perhaps bursting of his piece, or the apparent growth of his ramrod showed that something unusual was taking place, but that a squad of blue-jackets serving a 38-ton gun should be unaware, or even uncertain, if the 110 lb. of powder they were supposed to be firing had exploded or not is beyond comprehension. Even if the two guns in the fore turret were being fired simultaneously by electricity, the absence of recoil would have alone been sufficient to indicate that the gun had missed fire. That the rammer did not pass home might, it is conceivable, have escaped notice in loading the second round with the hydraulic gear, but we must look to the report of the Committee for some explanation of the first miss-fire having escaped notice.

In the many suggestions that have been made respecting the probable cause of the disaster by the writers of letters to the daily and weekly papers, it appears to us that a too low estimate has generally been made of the strength of the gun. It has been assumed by many that if it could be shown that the projectile slipped forward in the bore on the withdrawal of the rammer, a sufficient cause for the accident had been discovered. Experiments were at once tried at Woolwich which established the fact that when no ring-wad was used the shot frequently followed the rammer on its withdrawal for a distance of three or four feet. Instances have also been given of the bursting of fowling-pieces through an accidental stoppage of the muzzle by snow or a wad, and it was thought by many that a clear case had been made out for the cause of the explosion. Sir William Palliser's experiments, however, disprove the truth of this suggestion, for, many years ago, in firing an experimental 8-inch gun with various air spaces up to four feet between the powder charge and the shot, he found that there was no dangerous pressure in the bore. The gun made use of in this experiment was an old cast-iron 68-pounder which was converted into an 8-inch rifled gun, on Sir William Palliser's system by the insertion of a coiled wrought-iron tube 2½ inches thick. This gun was fired with 22 lbs. of powder and a shot of 180 lbs. weight, with successive air spaces of 10 inches, 20 inches, up to 50 inches between the powder and the shot, and sustained no damage. Sufficient experiments have not yet been made to indicate accurately all the variations of pressure that would be introduced by an air-space between the powder charge and shot, but the only cause which would tend to raise the gas pressure, and in particular the longitudinal and twisting strain on the gun, above that due to an ordinary discharge is the fact that the pitch of the rifling would be sharper where the projectile started in the former case than in the latter. In the case of a fowling-piece the cause of bursting with a slight stoppage at the muzzle is probably due rather to the weakness of the barrel at that part than to the excessive pressure. In the 38-ton gun, with the heaviest charges employed on service, the central part of the length of the gun known as the 1 B coil is probably amply strong enough to resist the pressure brought to bear upon it, even if the shot was in this part of the bore and the maximum gas-pressure exerted. Although it has been shown by the report of the Committee that none of the conjectures as to the cause of the accident is correct, there is still utility in examining them, for, if valid, they might bring about a similar accident at some future time, and should therefore be provided against. Though the running forward of the shot when the gun is much depressed for loading with the hydraulic gear would cause but a small risk of explosion to the gun, it is so undesirable for many other reasons, that means should be taken to render it impossible, or at least render its detection a certainty. The means at present employed to obviate the shifting of the shot when once rammed home, consist of a ring wad which fits round the pointed head of the shot, and is firmly wedged in between it and the bore. Here again we are provided with a very possible chance of an accident. The two letters of Sir William Palliser published in the *Times* pointed out what appeared to us, before the publication of the report, by far the most probable solution of the problem: it consisted simply in the employment at the same time of a gas-check and a ring-wad. As clearly pointed out by Sir William, it is merely a question of the relative coefficient of friction between the shot and the wad and between the wad and the surface of the bore, which has to decide whether the wad is forced along the bore when the shot commences to move, or whether the head of the shot is forced further into the wad, wedging it tightly against the surface of the bore. This action would be impossible without the employment at the same time of a gas-check, as the gas rushing past the shot would inevitably dislodge the wad. The gas-check consists of a cupped disk of copper with the periphery turned down so as to form a flange; this is fitted to the base of the projectile, and, when fired, the pressure of the gas causes the flange to expand and press firmly on the surface of the bore, both in the grooves and in the lands between them, thus preventing the passage of the gas past the shot. Sir William says: "With regard to the friction between the wad and the gun, it is a fact that when the atmosphere is moist the residue of the powder deposits itself upon the surface of the bore in a black, greasy substance which reduces friction to a very low point. On a dry day, however, this deposit assumes the

form of a hard, dry, and rough coating like emery paper, and the friction in the bore is increased to a very large extent." Thus it may readily be seen that under varying circumstances the requisite conditions are very likely to occur, and experiments should most undoubtedly be undertaken to test the validity of this source of accident, and we think that great credit is due to Sir William Palliser for having been the first to point it out. Yet another cause has been insisted on as likely to bring about the destruction of some of our Woolwich rifled guns. In a paper read by Prof. Osborne Reynolds at the meeting of the British Association at Bradford, it was shown that the system of rifling employed at Woolwich, giving a gradually increasing twist to the grooves, threw a much greater strain on the gun than a uniform twist, and rendered it impossible for the studs on the shot to fit the grooves with accuracy throughout the whole length of the bore. The objections raised by Prof. Reynolds have, we believe, remained unanswered and perhaps unnoticed now for five or six years by the departmental officers, and during this time many hundreds of guns have been constructed on the condemned principle. Now that so much public attention is being directed to the whole system of gun manufacture as carried on at Woolwich, and the criticisms adverse to its merits are so numerous it would be well that the country should have further assurance that the system is founded on a safe scientific basis, or that the errors, if they exist, should be admitted and rectified.

It is admitted that with the increasing twist in the rifling the shearing of the studs has frequently shown that the projectile has some difficulty in centring itself in the bore while the great wear in the steel tubes of the guns occasionally used for practice on board ship points to a short life for the gun, but we are not aware that the destruction of a gun has hitherto been traced with certainty to the jamming of the studs between two grooves. In the event of this occurring it is shown conclusively by Mr. Longridge, in a letter inserted in *Engineering* last week, that the strain would be far more than sufficient to burst the gun. The bursting pressure of the gases would easily split the tube and coils, or the energy of the shot if only moving with a moderate velocity would cause a longitudinal stress which the steel tube would be quite unable to resist.

It may appear to some useless to draw particular attention to the various causes of this terrible accident that have been suggested now that the report of the Committee has been made known and has shown that all the suppositions are equally erroneous, but in our opinion it is of the utmost importance that these dangers to which we direct attention and which might at any time cause a similar accident, should not be passed over and forgotten.

CAPTAIN COOK

IT seems on first thoughts rather a strange proceeding to publicly celebrate the centenary of the death of a great man, especially when that death was a murder. But this is what the Paris Geographical Society have arranged to do to-morrow in the case, not of any of their own explorers or navigators, but in the case of England's greatest exploring navigator, Captain James Cook, who was murdered 100 years ago to-morrow by the natives of the Sandwich Islands. But we know that the generous-minded Frenchmen do not intend to rejoice at the death of this great man, as they would do were it his birth they intended to commemorate. Cook, they know, was one of the greatest of geographical explorers, and it is quite natural and commendable that the Society, in their enthusiasm for their science and its promoters, should wish in some way to show their reverence for a man like Cook on the centenary of his remarkable death. Cook, and with him England, owed some gratitude to the French, whose government of the time, though at war with this country, generously gave instructions to their war-ships and colonial governors, not only not to molest Cook in his pursuit of knowledge, but to render him all reasonable assistance. It is obvious that only about every third generation can take part in celebrating the centenary of a man's birth, and it is natural, therefore, that those of the intermediate generation who count him among their heroes, should take advantage of the occurrence of the centenary of his death to show their appreciation of his greatness. In Cook's case birthday and death-day were only about half a century apart, the date of the former being October 27, 1728.

Why our own Geographical Society should have left it to our French neighbours to commemorate so remarkable an event in the history of geographical discovery, we cannot undertake to say, though it seems to savour somewhat of dog-in-the-manger that they have declined the invitation to send an official representative. It would surely have been easy for them to have organised some kind of demonstration that would both have honoured the memory of one of our greatest naval heroes and most scientific of navigators, and at the same time have proved both interesting and instructive to the public. However, England will not be entirely unrepresented to-morrow, as we understand the Admiralty are contributing several original charts to the exhibition of the Paris Society. Mr. Brassey, who has visited the spot where Cook was killed, has sent to the Society a number of views and documents to be exhibited. Mr. Jackson has also promised to send valuable maps and manuscripts from Cook's own hand. Researches will be executed in the Archives to discover the original of the *Ordre du Roi*, forbidding French cruisers to molest Captain Cook's expedition, and in spite of the declaration of war, to assist him if necessary for the fulfilling of a mission interesting the whole of mankind.

We need not recount the claims of Captain Cook to be regarded as one of the greatest, as he was one of the most scientific, of navigating explorers; probably there are few of our readers who have not at one time or other read some account of the voyages of Captain Cook. The son of a peasant, he rose to his honourable position by sheer force of genius and its invariable accompaniment, hard work. To him we owe the discovery of the Sandwich, and many other Pacific Islands. His enthusiasm on behalf of science was manifested in his work at Tahiti in connection with the memorable transit of Venus of June 3, 1769. He gave certainty to our knowledge of New Zealand, and left not much to be done to fill up with accuracy an outline of the coast of Australia. He proved

that that continent was unconnected with New Guinea, and above all, dispelled the long-lived illusion of a great southern continent, having been the first to cross the Antarctic Circle. At high south latitudes he sailed nearly all round the confines of the Antarctic, adding greatly to a knowledge of the geography of this unknown region, and proving once for all, as we have said, that a "great southern continent" was a delusion, at least outside the Antarctic Circle. A comparison of the maps of 1762 and 1785 will serve to show how much was accomplished by Cook in this direction. In his second voyage of three years, 1772-75, Cook sailed over 20,000 leagues in the Pacific and Southern Oceans. And it was not only geographical knowledge that was thus advanced by his skill and determination. He was always accompanied by a staff of scientific specialists, to whom he gave every opportunity of pursuing research in their own departments, and thus of adding enormously to a knowledge of the natural history (in its widest sense) of great tracts of our globe. In the Transit expedition, for example, he was accompanied by the young Joseph Banks as naturalist. His third, and fatal voyage, was undertaken mainly for the discovery of a North-West Passage, Cook and Capt. Clarke sailing in the *Resolution* and *Discovery* from Plymouth in July, 1776, and after a roundabout voyage by the South Pacific, the Sandwich Islands were discovered on January 18, 1778. After attempting to penetrate the Arctic Ocean, he was compelled to turn back, and resolved to spend the winter in completing the survey of the Sandwich Islands. Here, as almost everywhere else that he went, Cook won the hearts of the natives by his gentle, firm, and perfectly upright dealing, in this respect being a pattern to all explorers. The end is too well known, and we need not repeat the details of the sad event which happened at Karakakooa Bay, on the south side of Hawaii, on February 14, 1779. No blame can be attributed to Cook, and, probably, very little to the natives themselves. Had the lieutenant who accompanied Cook on shore, and the sailors themselves, possessed a little of his tact and true bravery the catastrophe might have been prevented. There is reason to believe that the islanders regarded Cook as a sort of superior being, a kind of heaven-sent messenger whom they half-expected, and that they actually worshipped him as a god. Indeed it has been said that it was only when the first stunning blow from a club proved him human that their chagrin and disappointment vented themselves in barbarous massacre. There seems no doubt that the natives were sincerely sorry for what had occurred, and continued to worship his memory, if not his bones, for long after. It is commonly stated that his remains were obtained and buried in the sea, but we would refer our readers to a remarkable story published in NATURE, vol. viii. p. 211. From this it would seem that the large bones of Cook's body had been retained by the islanders, and tended and enshrined as those of a hero, if not of a deity. Whatever amount of truth there may be in the details of this story, it, along with other evidence, tends to prove that the catastrophe was a sad mistake, regretted by none more than the natives themselves.

Cook's instincts were thoroughly scientific, and he did all that his circumstances would admit of to qualify himself to carry on his great and important work on the basis of scientific principles. The results show that all things considered science profited largely by his labours, and that to-morrow a foreign society will strive to keep green the memory of one of England's most scientific navigators, one of her ablest and most lovable sons.

THE SAMOAN LANGUAGE

A Grammar and Dictionary of the Samoan Language. By the Rev. George Pratt. Second Edition. Edited by the Rev. S. J. Whitmee, F.R.G.S. (Trübner and Co., 1878.)

THIS is perhaps as complete a guide to the study of the Samoan language as could be expected under the circumstances. It consists, properly, of four parts: a grammar, which, for obvious reasons, is necessarily disappointing; a chapter on the native poetry, which would be much more useful were the specimens given accompanied by a translation, or at least by more copious notes; an English-Samoan vocabulary of about 4,500 fairly well-selected words, and a Samoan-English dictionary of more than double that number of terms. The editor informs us that many of the names of the indigenous flora and fauna collected by him still remain to be published. They will doubtless be embodied in the large "Comparative Polynesian Dictionary" he is now preparing, and when this is done we shall have at last a well-nigh complete dictionary of the most typical of the eastern Polynesian languages.

The grammatical portion of the work, notwithstanding the many extremely useful and suggestive additions of the editor, still leaves so much to be desired that we cannot but regret he did not re-cast this whole section, and give us a treatise more in harmony with the present state of linguistic studies. When we read in Mr. Pratt's preface that he was led to prepare a Samoan syntax "by observing, while reading Nordheimer's Hebrew grammar, that the Samoan in many points resembled the Hebrew," we feel at once that it would be hopeless to expect from him a sound exposition of the structure of this language, and the most cursory glance fully confirms this anticipation. Hebrew is a member of the Semitic family of languages, and is consequently an inflecting tongue. Hence it can have nothing beyond mere coincidences in common with the Eastern Polynesian group, which has scarcely yet got much beyond the isolating state, of which Chinese is typical. Its position, in fact, is quite unique, and until its true character is thoroughly realised we shall never get a rational treatment of the subject. This obvious truth was largely recognised by Gaussin, which at once explains the satisfactory nature of his work. Had it been based on the Samoan instead of on the Tahitian and Marquesan dialects, the result would doubtless have been still more satisfactory, and he would have avoided some of the misconceptions which detract from the value of that treatise. Yet even so it incidentally throws more light on the real genius of the Samoan itself than does the present work. Here the treatment of the verb is especially meagre and irrational. The schemes of tense and mood occupy less than two pages, and each tense is illustrated by a different verb, *pule* (rule) for the present, *alofa* (love) for the imperfect, *sao* (escape) for the perfect,

&c. The consequence is, that we get no general scheme at all of any given verb, which, however, is perhaps the less to be regretted, inasmuch as there are no true verbs at all in the language. These Eastern Polynesian tongues have certainly got beyond the purely isolating state of the Chinese, in which each root passes in its unmodified state directly into the sentence, where it becomes a true word only in virtue of its position. But they have not yet reached the next, or agglutinating state, because in them all parts of speech are not yet clearly differentiated. The so-called verb is merely a nominal predicate with the various temporal, personal, and modal relations more or less clearly expressed by determining particles. Hence the so-called second person present *e pule 'oe*, here rendered "thou rulest," is made up of the enunciative *e* equally applicable to present and future time, to the infinitive and to other words such as all the numerals (*e tasi* = one, *e lua* = two, &c., with which cf. *a* hundred, *a* thousand, &c.), of the noun *pule* = order, command, rule, and of the pronoun *'oe* = thou. Thus, the whole expression merely attributes the rule or command, that is, *the thing* in a vague way to the subject, and seems scarcely to convey the idea of action, that is, of the use of the thing as does the true verbal form *regis*, thou rulest, in which the original nominal conception is completely absorbed in the idea of action. We thus see that the verb, as a distinct part of speech, is not yet developed, though there is an evident tendency towards its evolution. Hence these so-called verbs are incapable of any change to express mood, tense, person, and even the plural forms, in which reduplication plays such a large part, are adjectival, as may be seen by comparing *sisina*, the plural of *sina* = white, with *nonofo*, the plural of *nofo* = to sit. On these plural forms the editor supplies some excellent supplementary matter at pages 13–16, which throws a strong light on the great influence of euphony in the development of language in its earlier stages. His remarks on the subtle distinction between the particles *a* and *o*, roughly corresponding to our possessive, are also very good. If to the active or transitive and passive or intransitive notions obviously involved in the use of *a* and *o* respectively, we add those of the *voluntary* and *involuntary* states, nearly all the difficulties will be removed, and the law may be confidently laid down that *a* is used with objects over which we have *free control*, *o* with those we possess, so to say, independently of ourselves, and which we must use in a definite way. Thus: *loua fale* = his house, *i.e.*, which he needs must use as a place of refuge or shelter; but *lana va'a* = his canoe, which he can apply to twenty different purposes. So also in the Tahitian: *ta'u va'a* = my canoe; *to'u fare* = my house; for such is the amazing homogeneity of these eastern Polynesian languages that the most delicate distinctions are often found to pervade the whole group from New Zealand to Hawaii, or from Samoa to Easter Island after a separation in some cases of certainly not less than six hundred years.

Mr. Whitmee's notes betray altogether such a deep insight into the true genius of this linguistic family that we earnestly hope, when another edition of this work is called for, he may be induced to suppress the author's grammar, and give us in its stead a thoroughly rational treatment of the subject. It will then be also very desirable in all cases to give a literal, or at least a close, translation of the examples quoted in illustration of the various rules and principles laid down. Many phrases are given in the present edition which may be useful to those already acquainted with the language, but which, for want of such a translation, it is to be feared will be thrown away upon the ordinary student, who may not have the opportunity of consulting a teacher. In the actual condition of these languages particles necessarily play a very large part, and are constantly heaped up in the sentence to a degree that must be very perplexing to the beginner. Where possible these particles should be translated, and when this cannot be done, which is very often the case, their various functions in the sentence should always be carefully indicated. This may, no doubt, demand more space, but the space can be saved by giving fewer examples and explaining them thoroughly. A comparative table of Eastern Polynesian alphabets, illustrating the interchange of letters between the various dialects, and throwing some light on their peculiar phonetic system, would also be a desirable addition, and might be brought within the compass of one or two pages. But the essential point will always be to treat the language from a rational standpoint, independently of all fanciful Semitic, Aryan, or other affinities. The eastern Polynesian group has only just emerged from the isolating or lowest stage of human speech, and still hovers on the verge of the agglutinating or next stage, and must be dealt with accordingly. Hebrew, the classical tongues, English, French, and all others familiar to us, have passed upwards from the isolating through the agglutinating to the inflecting state, and have, therefore, little in common with Samoan, Maori, Tahitian, &c., beyond the faint reminiscences, still lingering on, of their former condition. When these simple truths are fully recognised grammarians may be expected to treat languages with some regard to their individual character.

A. H. KEANE

COAL AND IRON

Coal and Iron in all Countries of the World. By M. Pechar. (Manchester and London: John Heywood, 1878.)

AMONG the results of the International Exhibition at Paris which has just closed its doors, the reports and other permanent records of the actual condition of the great industries of the world are certainly not the least valuable. Even where, as in the case of the work now under review, the materials of comparison are not wholly or mainly derived from the Exhibition itself, still from it have been derived the desire and perhaps the opportunity to execute the work on so complete a scale.

The international character of the book is obvious from every part, even of the title-page; this is the authorised English edition; the subject it professes to treat is Coal and Iron in all Countries of the World; its author, M. Pechar, is a railway director in Teplitz, Bohemia. And it must be confessed that the contents of the book do not belie the title-page. Indeed, the first page of the General Remarks which introduce us to them would lead us to suppose that we were going to be treated to a

review not merely of all terrestrial space but of all terrestrial time as well, we are carried back "over an incalculable number of thousands of years" to the prehistoric time of crude tools of flint, bone, horn, and the like, and so by rapid strides through stone and bronze and iron to these last days, on which the age of steel is dawning.

This, however, is only by way of prelude, and the author straightway settles down to his facts and figures. These latter are naturally so numerous that the general reader will hardly find the book as a whole a light or entertaining one; yet apart from the very high value of the statistics for purposes of reference, there is much in the book to interest every one who cares for his country's or the world's welfare.

First, a few words with respect to the character of the statistics. These of course vary in completeness and in accuracy with the respective development or otherwise of the countries concerned, or of these special industries. With respect to our own country tabular statements are given of the number of pits for certain years between 1854 and 1876; of the production in each coal-district for the year last named; of the total produce in each year since 1854 as well as for certain years previously; of the percentage of increase in production and in value; of the chemical constituents of all the more important coals (sixteen in number); of the comparative heating power and general utility of certain English and Westphalian steam-coals used by the German navy; of the average price of coal for each year from 1865 and for certain years before; of the chief purposes to which the coal is applied and in what proportions; of the growth of British railways, and of the coal traffic thereon as well as by sea and canal; of the growth of British shipping; of the coal exports, and of the chief countries importing these, with the weight and value of their respective amounts. Add to these similar tables for the iron and steel industries of Great Britain; and multiply the total by a similar number of tables according to their degree for other great coal and iron producers such as Germany, United States, Belgium, and France; add also every available form of statistics for other parts of the globe, from the Arctic Circle to the Cape of Good Hope, and from Japan to Morocco, and one will readily admit that as a book of reference the work must be invaluable.

But the book is no mere statistical abstract. These tables, numerous as they are, are only scattered here and there throughout a very full and valuable text. The history of the rise and development of the great coal and iron industries here and elsewhere is stated briefly but sufficiently: the relative advantages and disadvantages of the several competing countries in their material and social aspects are well indicated: such questions as those of labour, increased or improved means of transport, the near prospects of such inventions as the Siemens-Martin and Bessemer steel processes, Barff's process for preventing iron from rusting, electric lighting, &c., are also discussed; and finally, the *literature* of the subjects dealt with is shown under each head at length, so that those whose special requirements demand more than even this work can give them, are at least shown where they may find the information they desire.

At a time of such profound depression in both these important industries, one naturally is eager to discover any rift among the clouds which the large accumulation of facts here contained, or the conclusions of so wide and an accurate an observer, may disclose. There is doubtless a consolation of a selfish kind to be got from observing that the state of affairs as to depreciation in the value of collieries and ironworks, in the prices of iron and coal, and in the wages of the workmen, is apparently quite as bad among our competitors as among ourselves. Thus the average price of coal in Germany was, in 1873, 10*s.* 9*d.*, and in 1877, 5*s.* 7*d.*; the wages, after rapidly rising, have now fallen back to the rates prevalent ten years ago, while the character of the workmen has deteriorated, and their relations to their employers have been changed in every way for the worse. In the iron trade the 125 joint-stock companies lost in 1877 alone a sum equal to 8·9 per cent. of their aggregate capital, which amounts to £24,335,709; and this capital at present represents, according to the quotation of the Berlin share-market, a current value of about £7,335,000 only. One regrets to notice that M. Pechar's chief remedy for these evils appears to be a return to protective tariffs so far as they have been abolished, and an aggravation of them where they exist. He is profoundly convinced that for many years to come no country in the world can hope to compete in the world's markets or even in their respective home-markets, with Great Britain in any but minor special products.

M. Pechar, however, has good hopes for the iron industry generally and consequently for the coal industry, whose fortunes depend so closely on those of iron. He expects that in most of the *present* applications of iron, steel will shortly supplant it, but that the iron industry will not therefore perish, but on the contrary will find new and larger spheres, partly as subsidiary to steel, partly by in its turn ousting wood and other substances from many of their present uses, as for example in buildings.

But it is unfair to summarise M. Pechar's conclusions apart from the many considerations by which he supports them, and we must therefore refer the reader on this and other points to the book itself. It will amply repay his perusal.

J. MARSHALL

OUR BOOK SHELF

Natural History, Sport, and Travel. By Edward Lockwood. (London: Allen and Co., 1878.)

MONGHYR is a large district in Bengal, divided into two nearly equal portions by the Ganges. Here Mr. Lockwood has spent many years as magistrate, and during that period had the inclination and the capacity to gather much knowledge of the district and its people. He laments in his preface that during twenty years' service he met only one Englishman (a Professor of Botany) who could identify the most common trees and plants. This is certainly lamentable, especially for the ignorant themselves, who thus miss a great and constant source of enjoyment and a fine opportunity of adding to a knowledge of the productions of one of our most important dependencies. This modest little volume is a good example of what may be done by a man who makes no pretensions to have more than a "desultory" knowledge of natural history. Mr. Lockwood is a very good observer, and his book contains many valuable notes on the animals and plants to be met with in the district of Monghyr. He has much

also to tell us about the people and their mode of life, the places of interest in the district, sporting experiences, and the various kinds of culture carried on. Altogether his volume is interesting and a distinct addition to our knowledge of the district over which its author ruled.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Weather, Past and to Come

SIMULTANEOUSLY with the appearance of some important remarks by Mr. Hyde Clarke, in the article "Sun-Spots and the Nile," NATURE, vol. xix. p. 300, I have been called up by a London clergyman of inquiring mind to answer the charge that a paragraph which he cut out of the *Times* last year, declaring on my alleged authority that that winter was to be severer in cold than any known for generations had been totally falsified by the event. I would request, therefore, Mr. Editor, a little space in your valuable pages for the following explanations:—

I give priority to Mr. Hyde Clarke, on account of his early labours in demonstrating a periodicity in human affairs, somewhat of the type of the sun-spot period subsequently discovered elsewhere. His remarks, too, now, of the probability of the existence of other periods of about 26 and 104 years, and that they "interfere," or mix up, with what he considers a ten-year period, are also worthy of note. In fact, they are the first public consent I have yet seen to my often insisted on conclusion from the Edinburgh earth thermometers, that the explanation of the eleven-year wave of heat exhibited there, being both immediately preceded and immediately followed by the deepest trough or wave of cold, for each whole eleven-year cycle on either side of it, was precisely caused by the near concurrence just there of two sets of waves of different periods of undulation. But when he goes on to say (line 38, p. 300) that such interference of two or more sets of undulations "prevented any absolute calculation as to the future," I object to the ruling of that sentence.

The complication may make the matter more difficult. It may oblige the State at last to set apart some good men for professionally prosecuting that subject, and to put them into a dungeon if they attend to anything else. But that is all! Two or three, even six or seven planets, pulling away at the earth and the earth at them in periods of different lengths and with different degrees of energy, do not prevent physical astronomers predicting the final outcome of it all on the earth's motion from day to day, and even minute to minute, and the alleged case of impossibility is only one of like kind.

But to the clergyman with the inquiring mind I would answer as follows:—

1. What I *did* write, in the summer of 1877, on the future weather is to be found at p. "25" of vol. xiv. of the "Edinburgh Astronomical Observations," a volume so liberally distributed by H.M. Government to scientific societies and libraries in London that no one there need have any difficulty in referring to my exact words if they are thought of consequence by any body.

2. Those words are, at all events, as to their general scope and bearing, widely different from the newspaper cutting alluded to. For while that treats only of a cold winter, my first and leading contention in the book was not about cold at all, but about heat. Namely, that the Edinburgh earth-temperature measures for forty years past show that a great *heat*-wave comes upon the earth from without, presumably from the sun, every eleven years, nearly; and that the date of the next such heat-wave was "1879·5, within limits of half a year each way." According to which the coming summer and autumn of this year may prove glowingly hot, and next winter unusually mild, in obedience to a grand cosmical action upon the earth as a whole. And who has yet disproved that?

3. My second, but only second and inferior, contention was, that such eleven-year heat-wave, of solar origination—contrary to the usual ideas of the learned as to the crest of a wave being removed from its trough or lowest point by about half of its length—was, in this case, both *immediately* preceded and *immediately* followed by a trough of extreme cold; the extremest cold, or lowest trough of each whole eleven years period on either side of the heat-wave's crest. Wherefore I contended (in 1877) that we had then still, between us and the good, warm time coming, a trough of extreme cold to wade through; and I did say that that preliminary cold-wave might be expected about 1878·0 "within limits of three-quarters of a year."

4. Because the winter of 1877-78 was not cold, and the winter of 1878-79 is now very cold, *in Great Britain*, the clergyman holds that my prediction was totally falsified. But to that conclusion I oppose the following consideration:—Is the surface of Great Britain large enough to be taken as expressing the condition of the whole globe under a cosmical influence from space without? Is not China much larger than the so-called Great Britain, and was not last winter preternaturally cold in China, with snow and ice down to the sea-coast even in lat. 29°, and inland such long-continued frosts and dry weather, that thence no crops, and the dreadful famine with depopulation of whole provinces?

Is not also the surface of North America larger than that of Great Britain; and at a central station of the former, Manitoba (as worthily reported and notified by Prof. E. D. Archibald in NATURE, vol. xix. p. 266) was not the December of the present winter astonishingly warm, almost hot, or no less than 25° above the mean temperature of former Decembers there?

5. Hence, if we look beyond our own immediate coasts, I suspect that the deficiency of radiation from the sun, called the cold trough, may have occurred, in reality, not far from the date I suggested in 1877, viz., in 1878·0. But as such influence from without has to act on the solid earth practically through the medium of an absorptive, locomotive, double revolving atmosphere, its full and extremest effects are experienced in different manners and at different dates in different parts of the earth.

Wherefore the "meteor" then becomes an affair for terrestrial meteorologists, not for astronomers, to follow up and explain; though the former may glean some useful hints from what the latter have long since ascertained as to the lunar tide-wave: viz., that it is raised, or coincides most nearly with a meridian full moon, near the middle of the Pacific; but at far different and later dates at other places, according to the length and difficulty of the path by which the tide-wave, once raised, has to travel to reach them.

PIAZZI SMYTH

15, Royal Terrace, Edinburgh, February 1

Sun-Spots and the Plague

Apropos of the plague—I do not know whether the following curious coincidence has been noticed. In that admirable work, John Graunt's "Natural and Political Observations upon the Bills of Mortality" (second edition, London, 1662), which is probably the earliest treatise on vital statistics, I find the following statement (p. 31):—"There have been in London, within this age, four times of great mortality, that is to say, the years 1592 and 1593, 1603, 1625, and 1636." He shows that large numbers died of the plague in each of these years. Now, if we take the solar period to be $10\frac{1}{2}$ years, nearly in accordance with Dr. Lamont's and Mr. J. A. Broun's estimates, we get the subjoined table, which sufficiently explains itself.

Corresponding solar years.		
1592·5	Plague in London	1592–3.
1603	,, ,,	1603.
1613·5		
1624	,, ,,	1625.
1634·5	,, ,,	1636.
1645		
1655·5	Great Plague in Naples	1656.
1666	,, of London	1665.
⋮		
1718·5	,, at Marseilles	1720.

If this particular coincidence has not already been pointed out, it deserves notice as supporting the theory that the rate of mortality is remotely connected with the solar period. There may be several chains of causation leading to the increase of mortality, but one chain is doubtless through the Asiatic famines, which would naturally develop the worst forms of germ disease.

W. STANLEY JEVONS

On the Combustion of Different Kinds of Fuel

I HAVE read with interest the criticism of Mr. I. Lowthian Bell (NATURE, vol. xix. p. 175) on my paper on the mode of combustion in the blast furnace hearth. You say with truth that the question is not simply technical, but is one of scientific importance. The prevailing opinions, which Mr. Bell has expressed with his usual force, rest upon experimental determinations of the gases in the hearth. I have never felt that trustworthy results have been obtained in any of the published analyses, and with your permission I would like to state the case, and see if my difficulties are removable by the wide experience of Mr. Bell or other investigators.

The blast-furnace hearth is a cylinder, closed at the bottom, but perforated near the top by a number of openings in which the tuyeres, or ends of the air blast-pipes are closely fitted. The air enters at a pressure which usually varies in anthracite practice between four and seven pounds to the square inch. As the discharge is at the top of the furnace, many feet higher, the air must describe a curved path from the point of entrance to the centre of the furnace, being acted upon continuously by a horizontal and a vertical force. It is evident that the level of the tuyeres is not the place to obtain the first products of combustion unless they are drawn through a tuyere in action. Elsewhere the samples would not be taken from the path of the air, which is upward from the tuyere from the instant it enters the hearth.

Mr. Bell and other investigators have analysed gases drawn from the hearth by means of porcelain tubes introduced through a closed tuyere aperture, or through holes drilled between the tuyeres. It seems to me these analyses are vitiated by the mode of drawing off the gas, and since this criticism applies to the experimental basis of existing views of combustion in confined spaces and with limited supplies of air, I will give a few details to show the scope of my objection.

At the Wear furnace Mr. Bell drew off gas through a tuyere that was closed for the purpose, but air was entering at other tuyeres on each side and four feet distant. Certainly this did not represent the product of that active combustion which takes place in the path of the air, but of these products after they had filtered through nearly four feet of glowing fuel. What the exact distance was depends upon the velocity of gas in the crucible of the Wear furnace and the inner diameter of the hearth, but was probably over three feet.

The quantity drawn off is not mentioned, but as it was taken for eudiometric analysis, the amount was probably less than five litres, and the movement of the gas through this glowing coal to the sample tube must have been extremely slow. Under these circumstances, whatever the product of combustion in the path of the air may have been, there could be only one gas drawn into the sample tube, and that would be carbonic oxide mixed with nitrogen. Even if we assume that the product of combustion in the furnace is carbonic anhydride alone (which is not true), this would be completely reduced to carbonic oxide by passing through the hot coal.

The experiments made on gas which was drawn through tubes in holes inserted between the tuyeres do not impress me more favourably. There the tubes were thrust "a little way into the contents of the furnace." That description does not apply to the mode in which gas samples were drawn off for analysis, but to experiments for testing the reducing powers of the gas by submitting pieces of ore to its action. Still it is probably also the mode in which samples were obtained, and the object of this note is to ascertain whether more careful means of sampling the unchanged products of combustion were used. If not, I submit that the analyses which form the basis of all modern reasoning on this subject must be rejected. The rapidity with which red hot carbon reduces carbonic anhydride, and produc s just the gas which experimenters find in their sample tubes, is well known, and methods of sampling which take no precautions to guard against this change cannot be accepted. I think the investigators owe it to science to give the world some hint of the means they have used to prevent this action, and to obtain the gas as it is formed. In the case of one of our American furnaces—a small on —the blast has an upward velocity of twenty feet per seco d at the level of the tuyeres, without considering the increase of volume by its rise in temperature in the furnace, and also allowing it to penetrate *instantly* to the centre, so as to cover the whole ar a of the crucible. That cannot be true, and on the other hand the withdrawal of gas from the walls at the tuyere level, while the air is entering with great velocity four feet away, can hardly give a fair sample of the unaltered result of immediate combustion.

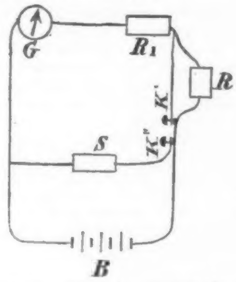
JOHN A. CHURCH

Columbus, Ohio, U.S.A., January 21

Internal Resistance

THE following method of measuring the internal resistance of a battery was devised some two years ago by Lieut. A. R. Conden, United States Navy, then attached to this station as Instructor in Electricity. It fulfils quite closely the conditions indicated by Clerk Maxwell on p. 412, vol. i. of his treatise on Electricity and Magnetism. As it is not generally known, I venture to call your attention to it.

In the figure, B is the battery, G a galvanometer, R and R_1 resistances, K″ a key for introducing the shunt S, and K′ another key for shunting out the resistance R.



When both keys are open the current through the galvanometer is—

$$S_1 = \frac{E}{B + G + R + R_1}.$$

When both keys are closed the current from the battery divides, part going through G and R_1, part through S. The current through the galvanometer is now—

$$S_2 = \frac{E}{B + \dfrac{(G + R_1)S}{G + R_1 + S}} \times \frac{S}{G + R_1 + S}.$$

If $S_1 = S_2$, then—

$$\frac{E}{B + G + R + R_1} = \frac{E}{B + \dfrac{(G + R_1)S}{G + R_1 + S}} \times \frac{S}{G + R_1 + S}.$$

Solving for B—

$$B = S \frac{R}{G + R_1}.$$

Finally, if R have been adjusted equal to $G + R_1$, then—

$$B = S \text{ directly.}$$

In practice R is a rheostat unplugged to equal $G + R_1$, and the two keys are combined in one. If the current be small enough with $G + R$ then R_1 may be omitted and R made equal to G. S is adjusted until, upon closing the double key, the deflection of the needle remains unchanged. The resistance of the battery is then the resistance of the shunt.

The case and concordance of the results obtained in this way through long series of measurements are no less striking than the rapidity with which the observations may be made.

Torpedo Station, Newport, R.I., January 12 — C. F. GOODRICH

The Formation of Mountains

MR. G. DARWIN has shown that, on the supposition that the earth is a cooling solid, the depth at which the maximum cooling and consequently, in all probability, the maximum contraction takes place, moves downwards, and, taking Sir W. Thomson's values of the constants, has not yet got down so far as 100 miles.

This shallowness of the layer hitherto chiefly affected is alone sufficient to prove how small an effect can be attributed to such a cause.

He inquires whether I may not have under-estimated the contraction of rock in cooling. In my calculation I put it at ·000007 linear for one degree Fahr. I derived this estimate from

the consideration of Mr. Mallet's experiments on cooling slag run from an iron furnace.[1]

This coefficient is somewhat larger than the mean of those obtained by Mr. Adie[2] for much lower temperatures. The mean of six of his values, half of them being for moist rock and half for dry, I find to be ·0000057.

Mr. Darwin recalls attention to M. Favre's experiments (out of which the present correspondence arose). M. Favre's experiments illustrate well the structure of an alpine district. But I would observe that, if ours is a cooling solid globe, and if that would give rise to such surface structure, we ought to find it everywhere, and not confined to definite geographical areas, as we do. O. FISHER

Harlton, Cambridge, February 8

Concerning the Colour of Eyes

MAY a portrait painter be allowed to remark that there are two kinds of green eyes, and the poets have duly appreciated both. The eye of the "green-eyed monster" is, no doubt, the cold grey, or stony blue eye, overspread with the yellow of biliousness, hence green; but when Dante called the eyes of the beatified Beatrice *emeralds* he did not mean to insult her. The image called up by his ecstatic words is that of those deep, soft eyes which are a warm brown in some lights—for instance with the light falling on them from one side only—and take a grey tint when facing the light of the sky, and green tints at other times, according to the lights that fall upon them; and are therefore sometimes a puzzle to portrait painters. Eyes, like the sea and precious stones, catch lights and transmute them. The sea is only green from the meeting of sunlight and blue sky light in it. J. M. H.

P.S.—Has it been remarked that the distinction between yellow and blue tints—the only one made by the colour-blind, according to Dr. Pole—is precisely the same as that made by the sun in photography: all the warm tints (as an artist—who makes the same distinction—would call those partaking of yellow) coming out darker, and all the cold ones—or those partaking of blue—lighter than in the object photographed?

Intellect in Brutes

A CORRESPONDENT in NATURE, vol. xix. p. 268, describes the actions of a water-rat which, he says, climbed up to a window-sill, inconvenient of access, and thirteen feet from the ground, in order to get some bread which was habitually put there for the birds during the cold weather. As the rat had never found food there before, the writer concludes that his conduct cannot be attributed either to instinct or to experience, but must be ascribed to a process of reasoning based on the observation of the flocking together of the birds, and the inference that they must be attracted by food. Now it seems to me that before we ascribe to a rat such complicated reasoning powers it is necessary to ask if there is no other, simpler, way of accounting for the phenomenon. I think there is. It is well known that different species of animals vary greatly in the acuteness of their senses. To man, sight is the most important sense, and the same is true of many other animals, and most birds. The cat is a representative of another, smaller, class of animals, whose most perfect organ of sense is the ear; while the dog lives in a world of sensations, the most important of which are contributed by the sense of smell. To this last class belongs the rat, which is noted for the acuteness of its scent. It is evident, therefore, that the water-rat in question was led to the window-sill by his nose, which, in his case, was a more trustworthy guide than his eyes would have been. I do not wish to deny, by any means, that animals have reasoning powers. On the contrary, I am convinced that human and brute intellect differ only in degree, not in kind; and I even adopt Haeckel's "cellular psychology," which attributes the elements of intellectual life—sensation and volition—to infusoria and organic cells in general, in opposition to the older "neural psychology," according to which psychic activity begins with the nervous system in the scale of animal life. But what we have to guard against is not to ascribe to animals reasoning powers of a higher type than is consistent with the development of their brain, especially when the actions which seem to postulate such powers can be readily accounted for by simply bearing in mind the extraordinary acuteness of one or more of their senses. We are altogether too prone to judge the intellectual life of animals by the human standard, to imagine that the eye is everywhere, as with us, the leading source of knowledge; and the neglect of the important *rôle* which the sense of smell plays in animal life has been particularly fruitful of errors in philosophical speculation. It has, among other things, helped to give a longer base of life to the old theory of instinct, regarded as a mysterious power of nature.

Berlin, February 8 HENRY T. FINCK

[1] *Trans.* Roy. Soc., paper read June 20, 1872.
[2] *Trans.* Roy. Soc. Edin., vol. xiii. p. 370.

Ear Affection

THE remarkable phenomenon described by your correspondent "P," in NATURE, vol. xix. p. 315, induces me to bring to your notice that precisely the same effect was produced in my own case a month ago, when partial deafness came on in both my ears, whilst suffering from congestion of the mucous membrane of the nasal passage and eustachian tube. Not being aware that any prior case had occurred of a distinct difference of a semitone, as indicated by the alternate application of a tuning-fork to the two ears, I at once drew up a memorandum on the subject, and handed it to Dr. Urban Pritchard, who was advising me. Like your correspondent "P," I have also noticed the double sound produced when I whistle, and more particularly when I close both ears with my fingers. G. L. WALLICH

February 11

Bees' Stings

THE American *Quarterly Microscopical Journal*, published last October in New York, contains an elaborate article on "The Sting of the Honey Bee," by J. D. Hyatt. Mr. Hyatt's experience does not tally with that of your correspondent, R. A. He says: "By allowing the bee to sting a soft piece of leather an excellent opportunity is offered for studying the action and mechanism, for the whole apparatus will be beautifully dissected, the *bee not appearing to be seriously injured by the loss*." I should be happy to send the journal to R. A. if I knew his address. W. RADFORD

Sidmouth

Electric Lighting

I NOTICE in an article in NATURE, vol. xix. p. 262, the following reference made to our electric light that it "does not appear to give very great satisfation through its fluctuation." It is true that at first we were caused some trouble owing to the Serrin lamp not working properly, but having overcome the difficulty we find it in our business, where it is necessary to show colours correctly, a very great improvement on all our former trials of lighting, and moreover, in its use we are not troubled in our galleries and upper floors with the heat and fumes which with gas alight no amount of ventilation seemed to remove.

It is not a pleasant light to read or write by owing to a certain flicker which seems common to all the regulators, but in warehouse or show-room use this does not cause any inconvenience, and we think in large places, especially those already having motive power, that it must eventually supersede gas.

Regent Street H. J. NICOLL

RELATION OF METEORITES TO COMETS[1]
II.

THERE are two classes of shooting stars which have been sometimes spoken of as unlike, but which are now admitted on all hands to be of common origin and character, namely, those which come in quantities on certain nights of the year, and give what is called a star shower, and the sporadic meteors, such as we can see on any clear night.

In November, 1799, von Humboldt saw during his travels in South America, a shower of shooting stars, and he has given a glowing description of the sight. These came on the morning of November 12. In 1832, November 13, there was seen in Europe a display of less brilliancy. It, however, attracted not a little atten-

[1] A lecture delivered in the Mechanics' Course at the Sheffield Scientific School of Yale College, U.S., by Prof. H. A. Newton. Continued from p. 317.

tion, as descriptions and newspaper notices show in every country in Europe. But no person seems to have connected it with any previous shower, nor does it appear that any one gave a hint of the true nature of the phenomenon.

The next year there appeared in this country, on the morning of November 13, a more brilliant shower, which some present doubtless witnessed. Through the morning hours of that day the stars shot across the sky like the flakes of snow in a snowstorm. Not a little difference was there in the way people looked at it. The negroes at the south thought the day of judgment had come. The owner of a plantation told me that his negroes had gathered in the "praise-house," and that he on being waked went down to quiet their fears. They had concluded not to call "Missus," as she would soon hear Gabriel's trumpet, and they well knew that she was ready to go. A student here in College was going to prayers, and saw a ball of light pass across the half lighted moving sky. He rubbed his eyes, thinking that something was the matter with them. A second flight made him sure that his eyes were troubled, and he looked down and hurried on to chapel. A servant girl by chance returning home in the early morning, saw it, but said nothing until it was talked of the next day. "Oh," said she, "I saw that." "Did you? Why did you not call us?" "Really, I didn't know but that the stars went out that way every morning." Prof. Twining saw it, and observing that all the flights were away from one point in the heavens, and that that point moved along with the stars as they rose in the morning sky, he said, "These are not, as some say, meteorological phenomena; they are not, as others say, electric; these are bodies coming to us from beyond the air, and they belong to astronomy." This was the first definite proof of the cosmic origin of meteors.

Nine hundred and thirty-one years earlier, that is, in the year 902, there was a like brilliant shower of fire. A cruel Aghlabite king then reigned at Tunis. He had driven the Christians out of Sicily, penning up the Bishop of Taormina and the remnant of his people in the church, and burning it and them together. He had crossed to the mainland, and was besieging Cosenza, then an important city of Calabria. He suddenly died, and the flying monks were relieved of their terrors. They connected his death with the star-shower which occurred at or near the same time, and in all the annals it is repeated in varied phrases that on the night when King Ibrahim Bin Ahmad died an infinite number of stars scattered themselves like rain to the right and left.

Between the years 902 and 1799 the November meteors were seen in unusual numbers in at least nine different years. The showers in the table which I show you are not selected out of an indefinite number in our histories. On the contrary, they are nearly all which we have found in the records as having occurred near that time of year.

Epochs of November Star-Showers

Year.	Day.
902	October 13
931	„ 16
934	„ 14
1002	„ 15
1101	„ 17
1202	„ 19
1366	„ 23
1533	„ 25
1602	„ 28
1698	November 9
1799	„ 12
1832	„ 13
1833	„ 13
1863–68	„ 14

Notice now in this table that the showers came either near the beginning or near the end of the first third, or else near the end of the second third of the century. In other words, they all come near the end of a cycle whose length was 33¼ years. Again, notice that the day of the month advanced with slight irregularity about three days in the century. The large advance of twelve days between 1602 and 1698 is due to the change of ten days in the reckoning in passing from old style to new style.

I have added, as you see, the six years from 1863 to 1868, in each of which, but especially in the latter three, these meteors came, as we had expected, on the morning of November 14. They seemed in all these years to pass, as they did in 1833, across the sky, as though going away from the constellation Leo, or rather from the sickle in Leo. This means that the small bodies really came into the air in parallel lines, the apparent radiation being the way in which parallel lines appear to us. There can be no doubt that there was the same parallelism of paths in all the earlier star-showers.

Here we have a group of solid bodies coming into the air all moving in one given direction. They come to us only on a particular time in the year, for the slow change from the middle of October to the middle of November can be explained. They come to us only at intervals of about a third of a century. These facts can only be satisfied by supposing that vast numbers of these small bodies are moving in a long thin stream around the sun, and that the earth, at the proper times, plunges through them taking into the air each time some scores of millions of them. Each of them must be moving in an orbit having the same period as every other, and approximately the same path.

Now it may be shown that there are but five orbits about the sun that can meet these conditions. Further than that, there is but one of these five that can explain the change of date from the middle of October to the middle of November, and this fifth one does explain the change perfectly. I cannot in the time you kindly grant me give in such detail that you can clearly understand them, the reasons for thus limiting the path of the meteoroids first to five possible orbits, and then to one of these five. I must ask you to accept the statement in view of the fact that no astronomer has, so far as I know, ever questioned the proofs of it.

That orbit is one which is described in 33¼ years. The meteoroids go out a little further than the planet Uranus, or about twenty times as far as the earth is from the sun. While they all describe nearly the same orbit they are not collected in one compact group. On the contrary they take four or five years to pass a given place in the orbit, and are to be thought of as a train several hundred millions of miles long, but only a few thousands of miles in thickness.

Now right along with this train of meteoroids travels a comet. It passed the place where we meet the meteoroid stream nearly a year before the great shower of 1866, and two or three years before the quite considerable displays of 1867 and 1868. It was therefore well towards the front in the great procession.

How came it that this comet and the meteoroids thus travel the same road—the comet with the meteroids and the meteoroids with each other? The plane of the comet's orbit might have cut the earth's orbit to correspond with any other day of the year than November 15. Or cutting it at this place the comet might have gone nearer to the sun or farther away. Or, satisfying these two conditions, it might have made any angle from zero to 180° instead of 167°. Or, satisfying all these, it might have had any other periodic time than 33¼ years; even then it might have gone off in any other direction of the plane than that in which the meteoroids were traveling. All these things did not happen by chance; there is something common.

The comet which I have named is not the only one that has an orbit common with meteoroids, though it is the only case in which the orbit of the meteoroids is

completely known aside from our knowledge of that of the comet. Every August, about the tenth day, we have an unusual number of meteors—a star-sprinkle, as it has been called. A comet whose period is about 125 years moves in the plane, and probably in a like orbit with these meteoroids.

So near the first of December we have had several star-showers—notably one in 1872—and these meteoroids are travelling nearly in the orbit of Biela's comet. In April, too, some showers have occurred which are thought to have had something to do with a known comet.

Thus much as to the meteors of the star-showers. The sporadic meteors are with good reason presumed to be (and observed facts prove some of them to be) the outliers of a large number of meteoroid streams, and the leading problem of meteor-science to-day is to find these streams so faintly shown, and, if possible, the comets they belong to.

Come back with me to the November stream and its comet. The several bodies move along a common path not at all by reason of a present physical connection. They are too far apart, in general a thousand times too far apart, to act on each other so much that we can measure the effect. No; their connection has been in the past. They must have had some common history.

Looking now at the comets, we see that they have been apparently growing smaller at successive returns. Halley's comet was much brighter in its earlier than in its later approaches to the sun. Biela's comet has divided into two, if not more than two, principal parts, and seems to have entirely gone to pieces. It could not be found in 1872, when and where it ought to have been visible. Several comets have had double or multiple nuclei. In the year 1366, in the week after the star-shower, a comet crossed the sky exactly in the track of the meteors. A second comet followed in the same path the week after. Both belonged no doubt to the November stream, and one of them may perhaps have been the comet of 1866.

This stream of meteoroids is a long thin one. In miniature it would be perhaps a mile long to an inch in thickness. We have crossed the stream at many places along a length of a thousand millions of miles, sometimes in advance of, and sometimes behind, the comet, and all along this length have found fragments, sometimes few, sometimes many. This form of the stream suggests continuous action producing it. A brief violent action *might* give this form, but a slowly acting cause seems more natural.

Again, in the history of Biela's comet we have distinct evidence of continued action. The comet divided into two parts not long before 1845, and yet in 1798 fragments of it were met with so far from the comet, that they must have left the comet long before, probably many centuries ago.

Thus are we led to say, *first*, that the periodic meteors of November, of August, of April, &c., are caused by solid fragments of certain known or unknown comets coming into our air; *secondly*, that the sporadic meteors such as we can see any clear night are the like fragments of other comets; *thirdly*, that the large fireballs are only larger fragments of the same kind; and *finally*, that this stone, which was broken off from one of those large fragments in coming through the air, must once have been *a part of a comet*.

Here I should naturally close, yet I am sure that you will ask, How came the comet to break up? Perhaps the prior question would be, How came the comet together? In its history there is much that we cannot yet explain, much about which we can only speculate. Thus, how came this stone to have its curious interior structure? As a mineral it resembles more the deepest fire-rocks than it does the outer crust of our earth. It seems to have been formed in some large mass, possibly in one larger than any of our existing comets. Some facts show that the comets have almost surely come to us from the stellar spaces. Out somewhere in the cold of space a condensing mass furnished heat for the making of this stone. The surrounding atmosphere was unlike ours, since some of these minerals could hardly have been made in the presence of the oxygen of our air. Either in cooling, or by some catastrophe, the rocky mass may have broken to pieces, so as to enter the solar system, having little or no cohesion, like a mass of pebbles; or, it may have come and probably did come, a single solid stone. In either case, as it got near to the sun, new and strong forces acted on it. The same heat and repulsion that develops and drives off from a comet in one direction a tail, sometimes a hundred millions of miles long, may have cracked off and scattered in another direction solid fragments. One of these contained in it this stone, and it wandered in its own orbit about the sun, itself an infinitesimal comet, how many thousands or millions of years we know not, until three years ago it came crashing through the air to the earth in Iowa. Thence this fragment came here to serve as a text to my discourse.

METEOROLOGICAL STATION ON BEN NEVIS

WE are glad to learn that the Scotch Meteorological Society's scheme of a station on Ben Nevis is evoking cordial support from those who have the administration of Government funds available for such objects. The London Meteorological Council, of which Prof. Henry Smith is chairman, has unanimously agreed to offer to the Scotch Society 100*l.* yearly towards the support of the station, provided a copy of the observations is sent regularly to London. This is at once testimony by the most competent judges to the importance of the scheme, and a proper encouragement to the Scotch Society to proceed in its spirited enterprise. We understand that to uphold the station and induce two competent observers to take it by turns to live on the top of the mountain with an assistant will cost about 300*l.* yearly. It is estimated that to purchase a full stock of instruments and erect a building for them and the observers a capital sum of 800*l.* will be required. The Scotch Society has applied for a grant of 400*l.* towards this expenditure from the Committee appointed by Government to distribute 4,000*l.* annually to encourage scientific research. We believe the Committee has not yet met to consider the various claims which are, no doubt, as usual made on the funds.

RESEARCH UNDER DIFFICULTIES

THE following short preface to a very valuable account of the stages of development from the egg of one of the centipedes (Geophilus), no member of which group had been studied previously to this account, gives so convincing a picture of the enthusiasm for investigation which may animate the modern naturalist, that it is worthy of a place in NATURE for the encouragement of the "craft." Elias Metschnikoff has during the past fifteen years worked more assiduously with the microscope at the observation of the minute details of embryology than any other student. To him we are indebted for our first accurate knowledge of this subject in the case of many important animal forms, *e.g.*, sponges, various jelly-fishes, marine worms, the scorpion, and the book-scorpions, various insects, crustaceans, starfishes, and ascidians. One result has been the injury of his eyesight. In reading to-day his memoir on Geophilus, published in 1875 (*Zeitschr. für wiss. Zoologie*), it occurred to me that the following passage has more than technical interest:—

"After having for many years sought in vain for material suited for the investigation of the embryology of the centipedes, I chanced to obtain a quantity of the eggs of

Geophilus. My find, however, took place under such circumstances, and these interfered so much with my investigation, that I feel justified in describing them more minutely. For some considerable time I had been afflicted with a chronic affection of the eyes, and consequently commenced in the spring of the present year a journey to our south-eastern steppes in order to turn my attention to anthropological studies. Instead of taking with me as in previous years all the apparatus necessary for microscopical research, I took this time on my journey only anthropological measuring instruments. When, then, I was in the neighbourhood of Manytsch, nearly in the heart of the Kalmuk steppes, and was visiting a small forest plantation, I discovered quite unexpectedly a number of eggs of Geophilus which had been deposited under the bark of a rotten tree-stem where the females were watching over them. I gathered up the precious material, and having packed it carefully in two bottles, set off with all speed to Astrachan, in order there to set about the microscopic investigation of the eggs. But when, after four days' travelling I arrived in a Russian village, Jandiki, near the shore of the Caspian Sea, and inspected my two bottles, I found in them only a couple of dead, opaque eggs, all the others having entirely disappeared. Fortunately I succeeded in Jandiki, where there is also a small plantation, in obtaining fresh material of the same kind, and this I brought in good condition to Astrachan, making the journey by steamboat. In the town of Astrachan I was able to borrow a Hartnack's microscope from a medical man practising there, and on a second journey took it with me to Jandiki. In this way I was enabled to make out the chief features of the developmental history of Geophilus by the use of my less seriously affected left eye. At the same time, in spite of the very favourable character of the Geophilus eggs for microscopic research, I could not bring my work to the desired degree of completeness."

Determination and pluck have their scope in embryology! E. RAY LANKESTER

ON THE RECENT ERUPTION AND PRESENT CONDITION OF VESUVIUS

AT the end of the great eruption of 1872 the crater of Vesuvius was left as a wide and deep abyss, the floor of which did not possess a very high temperature, and was free from fumarole. Gradually, however, fumarole appeared, the temperature increased, and large quantities of steam and carbonic acid were evolved. The temperature continued to increase and sulphurous acid made its appearance, finally in 1875 the evolution of carbonic acid diminished, and that of hydrochloric acid commenced. This is always the commencement of the highest stage of fumarole activity. In January, 1875, when I ascended the mountain, large quantities of sulphurous acid were being evolved, and it was quite impossible to descend into the crater. On December 18, 1875, a deep chasm opened in the bottom of the crater, at the bottom of which glowing lava could be seen. This was the commencement of a new period of eruption, which Palmieri predicted would last a long time, and which is still going on. The lava gradually rose to the top of the chasm, and a new eruptive cone was soon afterwards formed on the floor of the great crater. Small quantities of lava issued from time to time from the new cone, and spread over the interior of the crater, until on the night of November 1, 1878, it rose to the lowest portion of the edge of the crater, and began to flow down the great cone of Vesuvius in a north-westerly direction. The lava continued to flow in a somewhat intermittent manner until nearly the end of the year, but it did not go beyond the foot of the cone.

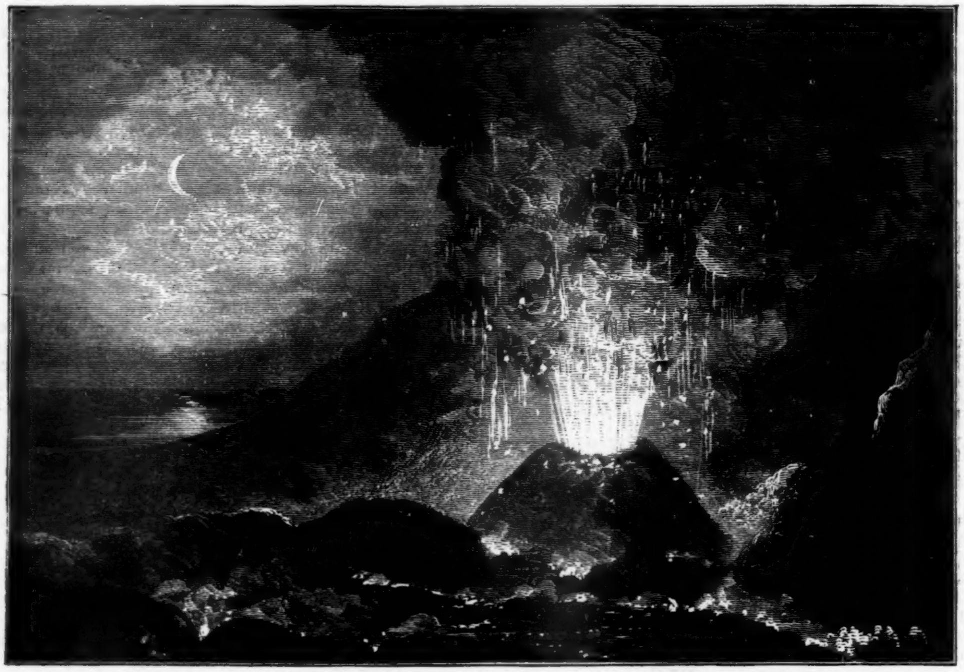
On December 29 last I visited the new cone. I left Naples at 8.45 A.M., drove to Portici, and walked to Resina. Left Resina on foot at 10 A.M., came upon the lava of 1451 (according to the guide, but I suspect it was lava of 1631) at 10.30, then bore somewhat to the west, and struck the lava of 1858. Reached the observatory at 11.15 A.M., the foot of the cone at 11.45, and the summit of the cone at 12.40 P.M. Thus the ascent of the cone occupied fifty-five minutes, including about ten minutes of rest. The angle is approximately 32°, and the ash of which the cone is composed is very loose. On arriving at the summit we turned to the west, and walked along the edge of the great crater, until we came to its south-western extremity, beyond which it is broken down by the recent flow of lava. Then we descended the crater by a very precipitous path, and presently found ourselves upon the new lava, surrounded on three sides by precipitous walls of apparently not more than 100 feet in height. Facing due north-east, we had on our right the new cone of November, 1878, and on our left the stream of lava which had issued from it, and which was still very hot, and in some places could be seen to be red hot a little distance beneath the surface. Occasionally a puff of very hot air was blown into our faces from the hotter portions of the lava. In many places hot fumes of hydrochloric acid escaped from the lava, and great cavities (in one or two cases small caverns), from whence the hot acid vapours issued, were coated with brilliant red and yellow sublimates of sesquichloride of iron. These sublimates are constantly spoken of as sulphur. I am inclined to assert that in more than ninety-nine cases out of a hundred, they are sesquichloride of iron formed either by direct sublimation of previously formed chloride from lower recesses in the lava bed, or by the action taking place then and there of the hot hydrochloric acid upon the exposed surfaces of the lava. Sublimations of salt were also apparent in certain portions of the lava bed. Prof. Palmieri informs me that he has detected sulphates in the sublimates, also lithium and boracic acid. I have not yet had time to examine various specimens of sublimates, which were collected from the new lava, and were placed in a dry bottle as soon as I reached Naples.

Prof. Palmieri has kindly furnished me with a MS. account of "Il Vesuvio dopo la grande eruzione del 1872," from which some of the above facts were derived. My own recent experience on the mountain does not, however, allow me to agree with him when he says: "Comunque sia, in tutto il tempo trascorso il cratere ha di mostrato poca attivita dinamica. Pochi brani di lava gettati fino all' altezza di 20 o 30 metri, soffii piu o meno vigorosi e qualche rara detonazione han rappresentato il vigore della forza eruttiva." The new cone, when I saw it, was pouring out vast volumes of smoke and steam, detonations occurred at frequent intervals, and loud noises as if of the lava surging within the crater. At intervals, also, the smoke was intensely illuminated as if the lava had leapt up within the cone. The cone discharged a perpetual shower of red-hot pieces of lava of a more or less cindery character, and certainly to a height far exceeding the "20 o 30 metri" of Prof. Palmieri. It is difficult to judge of heights under such circumstances, but many of the fragments appeared to be projected to a height equal to that of an ordinary sky-rocket. The ejected masses nearly all fell on one side of the cone, and helped to raise it. Occasionally, however, a sudden burst would come which scattered the red-hot masses in all directions. We approached as near as we could to the cone, and stood upon the bank of cinders (*vide* the accompanying woodcut) in immediate contact with it, and not a dozen yards from its vomiting crater. Showers of red-hot stones were projected from the crater, many of which fell into it again, and the rest for the most part on the side remote from us. There came a sudden burst, however, which shook the ground under our feet, and scat-

tered red-hot masses in all directions. A piece weighing four ounces fell within six feet of where I was standing, and the guide ran up to it and pressed a copper coin upon its still soft surface. A few minutes later a piece of red-hot lava, weighing at least seven times as much as the preceding, fell within four feet of me, and I promptly retired to a safer distance. Fifteen days before a guide had been killed by a falling red-hot stone from the crater. The projectiles from the crater are doubly dangerous, because you cannot "dodge" them. They do not come down straight like a cricket-ball, but waver in their flight like a boomerang. In the case of the larger of the two masses which fell so near to me, I had not only time before it fell to watch it in the air above my head, but also to speculate as to where it would fall. Judging by its position when about forty feet from the ground, it would certainly, I thought, fall behind me; a moment later it swerved, and fell about four feet in front of me. The cone, with its lurid smoke, and loud detonations, and showers of red-hot stones, presented a most fascinating spectacle. What, then, must be the effect when the whole great cone of Vesuvius is in a like condition?

The new lava is very leucitic, and does not resemble that of 1872. When in a viscous state it can easily be drawn into threads, and when cold it is jet-black and possesses a fine lustre.

Chloride of ammonium does not appear to have been at all a common product in this eruption, although it was conspicuously present during the eruption of 1872. Great differences of opinion still exist as to the formation of sublimates of chloride of ammonium in lavas. Bunsen considers that it is mainly formed by the action of the hot lava upon vegetable soil, and he has proved that "a square metre of meadow land yields on dry distillation a quantity of ammonia corresponding to 223·3 grammes of chloride of ammonium." Palmieri, while he admits that he has found more chloride of ammonium in those portions of lavas which have passed over cultivated ground, asserts that he has also found it high upon Vesuvius far above the range of vegetation, and in localities where the new lava has simply flowed over older and perfectly barren lava fields. He accounts for its formation by supposing that aqueous vapour undergoes dissociation in the heated crevices of the lava, and that the nascent hydrogen combines with the nitrogen of the air to form ammonia. We do not know what chemists will have to say to this theory.



New Eruptive Cone within the Crater of Vesuvius, which opened on November 2, 1878, and is still active.

Not far from the active cone I found a very interesting specimen of volcanic cinder which had obviously been exposed to the action of hydrochloric acid at a very elevated temperature, and had then probably been ejected before the action was complete. The central portions consisted of undecomposed cinder, and this was surrounded by a thick layer of perfectly white decomposed substance consisting chiefly of silicate of alumina and silica; the hot hydrochloric acid having formed sesquichloride of iron with the iron in the superficial layers of the mass, which sesquichloride had been afterwards volatilised out of the mass. By passing hydrochloric acid over lava heated to redness in a porcelain tube, the same effect was produced, the portions of lava most strongly heated, and longest submitted to the action of the hydrochloric acid, became perfectly white, while a copious sublimate of chloride of iron and chloride of aluminium passed into the receiver.

I ascended from the new lava (viz., from the bottom of the great crater of Vesuvius, *vide* the foreground of the accompanying woodcut) at 1.30 P.M., ran down the sides of the great cone, which had taken fifty-five minutes to climb, in seven minutes, reached the observatory at 2.30 P.M.; Portici, by a roundabout way to the west near Monte Somma, whither we went to search for minerals, at 4.30 P.M.; and Naples at 5.40. The next evening

while steaming out of the bay, *en route* for Tunis, I noticed that the smoke at the apex of the mountain was ruddy from the reflection of the lava within the small crater of 1878, and then for many days after, the summit of the mountain was obscured by clouds, and snow lay upon it when I next saw it towards the middle of last January.

G. F. RODWELL

POPULAR NATURAL HISTORY[1]

VOLUME II. of this handsomely illustrated work on natural history is equally well got up as the first, which we noticed some months ago; it contains brief histories of the Carnivora, Cetacea, Sirenia, Proboscidia, Hyracoidea, and Ungulata.

The terrestrial, or on-the-land-living Carnivores, are described by Mr. Kitchen Parker, assisted by his son Jeffery. The father's pleasant style and his power of apt illustration will be recognised in the too few pages introductory to this group, and some of the woodcuts are from drawings made by the author. The marine Carnivora, the Whales, and the Sirenia, are described by Dr. Murie, while the editor, with the assistance of Prof. Garrod and Mr. Oakley, describes the Proboscidia, the Hyracoidea, and the Ungulata.

The land carnivora are, undoubtedly, as Mr. Parker tells us, one of the most compact as well as one of the most interesting groups among the mammalia. So many of the animals contained in it have become "familiar in our mouths as household words," bearing as they do an

FIG. 1.—The Binturong (*Arctictis binturong*).

important part in fable, in travel, and even in history. Many of them are of wonderful beauty, and many of them are of terrible ferocity. Two she-bears out of the wood tore up the forty and two naughty mocking little children near Bethel, and the narrative thereof frightens our own little children to this day. Packs of enraged lions, "fierce with dark keeping," were by the noble Romans let loose to mangle and devour helpless men and women in the arena, and as for the wolf, what terrible stories are not told about him? He was the very dread of the shepherd in the far distant times. As Mr. Parker reminds us, his bad character for ferocity was so well known in the early days, that "a very old sheep-master, addressing his sons on his death-bed, these sons being eleven out of twelve of them shepherds, said, knowing they would understand him, of the youngest, 'Benjamin shall raven as a wolf: in the morning he shall devour the prey, and at night he shall divide the spoil.'"

And with all this ferociousness of character, it is from among the number of the land carnivora that man has selected his faithful and devoted follower the dog. For a wonderfully interesting account of this friend of our race, a friend in whom, as Mr. Darwin observes, it is scarcely possible to doubt but that the love of man has become an instinct, an instinct, as Mr. Parker naively observes, not as yet certainly developed in man—there is a pleasant chapter, one that tells of what is known of prehistoric dogs, of the origin of the dog, and of the many varieties of the dog.

As an illustration of the general character of the woodcuts which so profusely adorn the volume, we have

[1] "Cassell's Natural History." Edited by P. Martin Duncan, M.B., F.R.S., Professor of Geology, King's College, London. Vol. ii. Illustrated. (London, Paris, and New York: Cassell, Petter, and Galpin.) 4to.

selected one of an interesting animal which has been a great puzzle to the systematic zoologist (Fig. 1).

"The Binturong (*Arctictis binturong*) is a curious little animal of a black colour, with a white border to its ears; it has a large head and a turned-up nose; its tail is immensely long, thick, and tapering, and which is very remarkable, it is prehensile, like that of a new world monkey. It is from twenty-eight to thirty inches in length from the snout to the root of its tail, and the tail itself is nearly the same length. It is quite nocturnal, solitary, and arboreal in its habits. In creeping along the larger branches, it is aided by its prehensile tail. It is omnivorous, eating small animals, birds, insects, and fruits. Its howl is loud. It walks entirely on the soles

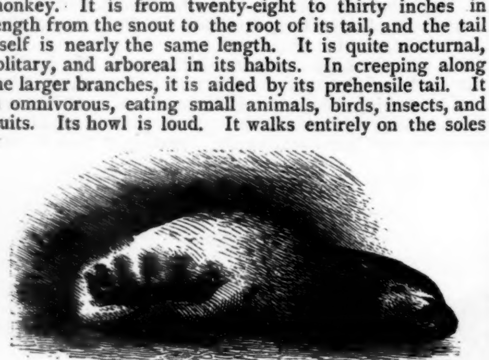


FIG. 2.—The Seal asleep.

of its feet, and its claws are not retractile. While it is wild and retiring in its manner, it is said to be easily tamed. It is placed by Mr. Parker among the group of the civets."

In his description of the fur and hair seals, Dr. Murie, as was to be expected, is quite at home, and we have, among other accounts of these wonderful creatures, a long one of that sea lion which lived so long in the London Gardens. This animal seemed to pass its time between sleeping and eating, and we give two out of a series of illustrations which depict its habits—one of it when fast asleep (Fig. 2), the other when it is in "a watchful attitude," waiting to be fed (Fig. 3); it was well known to all visitors to the gardens. It was in the habit of devouring upwards of twenty-five pounds' weight of fish every day, and not thinking this too much. It was originally captured in

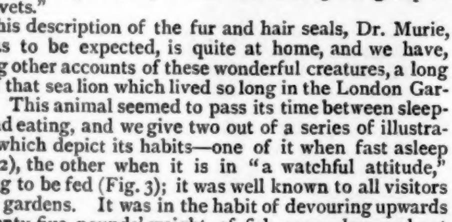


FIG. 3.—Waiting to be fed.

the neighbourhood of Cape Horn; and François Lecomte, the French sailor into whose possession it fell, exhibited the animal for a short time at Buenos Ayres before bringing it to London, where for a short time he earned a living by showing it off. By kindness and dint of training he taught it to become quite a performer in its way. It mounted a ladder with perfect ease, and it could descend either head or tail foremost, so that it seemed a marvel of docility, and its appearance in London seems to have created quite a general interest in the group hitherto so little studied of the eared seals.

The volume concludes with an account of the non-ruminating members of the even-toed sub-order of the Ungulates, embracing the pigs of the Old World, the peccaries of the New World, and the hippopotami. The next volume will contain a description of the Ruminants, a large and very interesting group. E. P. W.

THE KEITH MEDAL OF THE ROYAL SOCIETY OF EDINBURGH.

ON the 3rd inst., at a meeting of the Royal Society of Edinburgh, the President, Professor Kelland, in presenting the Keith Medal which had been awarded by the Council to Professor Heddle, of St. Andrews, delivered the following address:—"Professor Heddle—I am here to-night to exemplify a remark which is often made, that to insure success in an address, such as I am about to deliver, the best way is to commit the charge of it to one absolutely ignorant of the subject. No false pride will then stand in the way of the best sources of information, nor will any undue admixture of half knowledge clog and darken the truth. For every particular contained in these remarks, then, I at once unhesitatingly acknowledge myself indebted to Professor Geikie. When I first became acquainted with this Society, forty years ago, there used to frequent our meetings men who had the reputation of being mineralogists rather than geologists—Lord Greenock, Allan, and perhaps Jameson himself. That race has now died out, and with them mineralogy, as a distinct science, has all but lain dormant amongst us. During the preceding quarter of a century that science had flourished nowhere more vigorously than in Edinburgh. Professor Jameson introduced the definiteness of system of the Freyberg School, and infused into his pupils such a love of minerals that numerous private cabinets were formed; while under his fostering care the University Museum grew into a large and admirable series. One of my first acts as Professor in the University was to vote out of the Reid Fund, which had just come into our hands, a large sum (some thousands) to pay back moneys expended on minerals throughout a series of years preceding. During these years, Geology, as the science is now understood, hardly existed. For, as the nature and importance of the organic remains embedded in rocks became recognised, their enormous value in the elucidation of geological problems gradually drew observers away from the study of minerals. Consequently, as Palæontology increased, Mineralogy waned among us. To such an extent was the study of minerals neglected, that geologists, even of high reputation, could not distinguish many ordinary varieties. But, as a knowledge of rocks presupposes an acquaintance more or less extensive with minerals, the neglect of mineralogy reacted most disadvantageously on that domain of geology which deals with the composition and structure of rocks. The nomenclature of the rocks of Britain sank into a state of confusion, from which it is now only beginning to recover. To you, Professor Heddle, belongs the merit of having almost alone upheld the mineralogical reputation of your native country during these long years of depression. You have devoted your life to the study, and have made more analyses of minerals than any other observer in Britain. You have not contented yourself with determining their composition and their names; you have gone into almost every parish in the more mountainous regions, have searched them out in their native localities, and, by this means, have studied their geological relations, treasuring up evidences from which to reason regarding their origin and history. After thirty years of continuous work, you have communicated the results of your labours to this Society. For the first two of these papers on the Rhombohedral Carbonates and on the Feldspars, in which you have greatly extended our knowledge of pseudomorphic change among minerals, enunciating a law of the shrinkage so frequently resulting therefrom, the Society proposes now to express its gratitude to you. The value of your papers is undoubted.

Through the kindness of Mr. Milne Home, I have been favoured with the sight of letters addressed to you by four eminent mineralogists, Dana of America, Rammelsberg of Berlin, Szabo of Buda-Pesth, and King of Queen's College, Galway. Szabo states that the notice of your paper on the Feldspars, which appeared in Groth's *Zeitschrift für Mineralogie*, greatly interests him, and makes him desirous of placing himself in direct communication with the author. Dana says, 'I have read your paper on the Feldspars, in the Transactions of the Royal Society of Edinburgh, with great satisfaction. Your thorough method of work leads towards important results of great geological, as well as mineralogical value.'

"I have the satisfaction, in the name of the Council of this Society, of presenting you with the Keith Medal. It is hoped that this recognition of your labours will not be without encouragement to you in the arduous researches in which you are engaged."

OUR ASTRONOMICAL COLUMN

TEMPEL'S COMET, 1867 II.—Now that Brorsen's comet of short period is again under observation, the next comet of the same class to be sought for, is that discovered by Dr. Tempel at Marseilles, on April 3, 1867, which was also observed at its next appearance in 1873; it is probable there may be greater difficulty in recovering this object, than appears to have been the case with Brorsen's comet, the reason for which may be made clearer if we briefly detail its history since the year 1867. Less than a month after it was discovered in that year the deviation of the orbit from a parabola became evident, and several of the German astronomers, Prof. Bruhns, now Director of the Observatory of Leipsic, in the first instance, deduced elliptical orbits, with periods of between five and six years. The most complete investigations on the motion of the comet in this year were due to Dr. Sandberg and Mr. Searle. The comet was observed by Dr. Julius Schmidt at Athens till August 21, and the perihelion passage having taken place on May 23, a considerable arc of the orbit was included within the limits of visibility. Dr. Sandberg, after taking into account the effect of planetary perturbations during the comet's appearance, found the period of revolution 2,080 days. On examining the track of this body with reference to the orbits of the planets, it was seen that near the aphelion it must approach very near to the orbit of Jupiter, the least distance being within 0·37 of the mean distance of the earth from the sun, and from the position of this great planet near the time of aphelion passage of the comet early in 1870, it was obvious that great perturbations in the elements of the latter must ensue, and without at least an approximate knowledge of their amount, there might be difficulty in recovering the comet at its next return to perihelion. The first publication of results in this direction was by Mr. W. E. Plummer, from Mr. Bishop's observatory, Twickenham, in February, 1873, followed shortly afterwards by particulars of similar independent investigations undertaken by Dr. Seeliger, of Leipsic, and the late Dr. von Asten, of Pulkowa. It was found that the effect of the attraction of Jupiter, which planet was only 0·32 distant from the comet on January 20, 1870, caused a retrograde change in the longitude of the node to the amount of $22\frac{1}{2}°$, and increased the inclination of the orbital plane to the ecliptic nearly 3°; the period of revolution was lengthened by more than three months, and the point of nearest approach to the sun was removed further from him by upwards of 0·2 of the earth's mean distance. Changes in the elements to this amount would of course entirely alter the track of the comet in 1873, but they had been so closely determined, that immediately after receiving an ephemeris in which their effect was included, M. Stephan re-detected the comet at Marseilles, and as early as April 3, or five weeks before the perihelion passage, and it was observed until the last week in June. We subjoin Dr. Sandberg's elements for the two appearances:—

	1867.		1873.
Perihelion passage	May 23·9204 G.M.T.		May 9·0134 G.M.T
Long. of perihelion ...	236° 9′ 24″	... ...	237° 38′ 42″
,, ascending node	101 10 10	... ...	78 44 39
Inclination to ecliptic ...	6 24 36	... ...	9 44 13
Angle of excentricity ...	30 38 39	... ...	27 30 58
Log. semi-axis major ...	0·503658	... ...	0·517057
Revolution	2080·1 days.	... ...	2178·6 days.

The longitudes are reckoned from the mean equinox of the commencement of the respective years. The period of revolution applies to the ellipse which the comet was describing at perihelion passage.

With regard to the length of the actual revolution, it is certain that no very material perturbation can result from known causes: Jupiter, the great disturber of the cometary motions, was at almost his greatest possible distance from the comet when the latter passed nearest to his path about May, 1876. A recent investigation by M. Raoul Gautier, of which, however, no details are yet published, assigns a longer period of revolution corresponding to the perihelion passage in 1873 than was given by Dr. Sandberg, the difference being about $10\frac{1}{2}$ days, so that if the mean motion at the last appearance does not, as M. Gautier implies, admit of exact determination, there will be an uncertainty in the date of the approaching perihelion passage, which will necessitate a pretty extended and careful search in order to detect the comet. It belongs to the fainter class, and although in 1867 and 1873 it appeared under rather favourable circumstances for observation, and is likely to do so to a certain extent this year, it has never been a good telescopic object. When at its greatest intensity of light early in May, 1867, its nucleus, which was stellar, had not the brightness of a star of the ninth magnitude. At the last observation at Athens, in that year the theoretical intensity of light was 0·21, and the comet would have the same degree of brightness about March 27 next, whether we assume the time of perihelion passage (perturbation neglected) from the orbit of Dr. Sandberg or M. Gautier, but the uncertainty of position may probably delay its rediscovery till some time later. We may hope that the publication of the further results of M. Gautier, who mentions being engaged on the calculation of perturbations during the present revolution, will not be long deferred. It is desirable the comet should be under observation as long as practicable at this return, since the period being now nearly equal to half that of Jupiter, the two bodies will come into proximity again towards the month of November, 1881, though their mutual distance may not be less than 0·55. This will involve a new, strict investigation similar to those undertaken in 1873, to enable the epoch of ensuing perihelion passage to be ascertained.

Using Dr. Sandberg's orbit of 1873, the comet's place at Greenwich midnight, on March 27, would be in R.A. 253°·9, N.P.D. 103°·7, or, if the perihelion passage be assumed ten days later, which would more nearly accord with M. Gautier's calculation in R.A. 247°·0, N.P.D. 101°·0.

THE INTRA-MERCURIAL PLANET QUESTION.—It appears that this subject has lately engaged the attention of that excellent practical astronomer Dr. Oppölzer, of Vienna, who has communicated to the *Astronomische Nachrichten* some curious results of his examination of the records of rapidly-moving dark spots upon the sun's disk. His inquiry resolves itself simply into the conclusion, that even introducing rather more extended data than were used by Leverrier, who, it will be remembered, found several possible periods of revolution for the hypothetical planet, they may all be represented so far as regards the necessity of a transit across the sun's disk on

the days named, by an orbit, the elements of which Dr. Oppölzer gives as follows :—

Epoch 1850, January 1·0, Paris M.T.

Mean anomaly	356° 0′	
Longitude of perihelion	27 45	Equinox of 1850.
„ „ ascending node	178 0	
Inclination to ecliptic	7 0	
Angle of excentricity	14 13 or $e = 0·2456$	
Log. semi-axis major	9·0906	
Mean diurnal motion	22°·789529	

The period of revolution would therefore be 15·797 days. Comparing with the observations employed the following are the differences shown by the above orbit in geocentric longitude; the calculated geocentric latitude is annexed :—

	Diff. longitude.	Latitude.
1800, March 29, Fritsch	+ 0°·6	+ 14′
1802, Oct. 10, „	+ 0·4	− 14
1819, Oct. 9, Stark	+ 0·2	− 13
1839, Oct. 2, Decuppis	+ 0·5	− 7
1849, March 12, Sidebotham ...	− 0·8	− 7
1857, Sept. 12, Ohrt	+ 0·1	+ 7
1859, March 26, Lescarbault ...	0·0	+ 10
1862, March 20, Lummis	+ 0·1	+ 2

But it is unfortunate that notwithstanding this almost perfect representation of the longitudes assumed and the circumstance that the latitudes point to a transit across the sun's disk on every date, there are apparently fatal objections to our admitting the existence of a planet with these elements, several of which are pointed out by Dr. Oppölzer. It may be sufficient to mention here the first of them :—With so short a period and small inclination, a transit across the sun's disk would occur every year, and we know that observation by no means supports such a condition. However, the existence of a body moving in this orbit will admit, as Dr. Oppölzer states, of very early decision :—On March 18 a nearly central transit should occur—

	h. m.		
Ingress at	18 8 Berlin M.T. ...	Angle of position	74°
Egress at	23 15 „ ...	„	254

We give these particulars as affording another illustration of the difficulties attending any trustworthy inferences from the observations of suspicious spots upon the sun's disk. The above orbit, it should be mentioned, will not accord with either of Prof. Watson's presumed planets, though possibly, by increasing the excentricity, elements might be found which would agree with one or other of his positions, while representing most of the observations used by Dr. Oppölzer. We ignore the idea of a want of *bona fides* on the part of the observers on so many occasions, but there is still to be remembered the fact that comets have traversed the sun's disk, and with small perihelion distances might do so without our discovering them except in the course of transit, supposing them to possess the degree of condensation which some have indicated. The object observed by M. Coumbary at Constantinople in May, 1865, could only have been a comet, with a perihelion distance so small as, like the great comet of 1843, almost to graze the sun's surface.

GEOGRAPHICAL NOTES

AT the meeting of the Geographical Society on Monday, when the Earl of Dufferin occupied the presidential chair for the second and last time, Mr. T. J. Comber, of the Baptist Missionary Society, who is about to lead an expedition above the Yellala Falls of the Congo, gave some account of his explorations inland from Mount Cameroons, in the course of which he visited a district of country previously unknown, and discovered a small lake to the northward of the mountain; he also ascertained that there was a broad valley there instead of a continuous mountain range. He mentioned one fact with regard to Mount Cameroons, which goes far to show that there may be some difficulty in finding a suitable spot for the proposed missionary sanatorium. When at an elevation of 2,000 feet there were such heavy mists, that, although he slept between two fires, his blanket was wet through. It is, of course, possible that here, as in the Neilgherry Hills, and other places, positions may be found to which the miasmatic influences do not extend. Mr. Comber next gave some brief and interesting notes of a journey which he made through Congo to Makuta, the place which Lieut. Grandy saw from the brow of a neighbouring hill, but was not allowed to enter. Sir Henry Barkly afterwards read some observations on the Bamangwata country in South Africa, to which a melancholy interest attached from the fact of their having been drawn up by the late Capt. R. R. Patterson, who recently met with his death by poison when some three days' journey from the Victoria Falls of the Zambesi. The country would appear to be of a not very promising nature, for its soil is sand, covered with stunted bush, and there are few mountain fastnesses, except those near Shoshong, the capital; in the winter it is badly watered, as the Limpopo, Zambesi, and Zouga (or lake river), are the only rivers which run continuously, while the Tati, Shasha, and Makalapogo, are sand rivers. The open country is sparsely inhabited by Veld-people of two classes, the Bakala and Masarwa, of whom the former enjoy the right of possessing cattle and gardens, but the latter neither; they are, in fact, slaves, living on game and roots. The Bamangwata country is ruled by a chief named Khame, whom Capt. Patterson described as a very good man, an opinion in which Sir H. Barkly concurred.

IN connection with the meeting on Monday at Preston in reference to a Central African railway, the letter in yesterday's *Times* from the Alexandria correspondent of that paper is of interest. It seems that the Khedive had some time ago devised an excellent scheme for bringing the riches of the great lake district to the outer world by way of the Indian Ocean, at the mouth of the Juba river. The distance between that point and Victoria Nyanza is only 280 miles, and McKillop Pasha was instructed to work gradually from the coast, planting colonial stations at regular distances, while Gordon Pasha was to co-operate from the lake side. Though the plan seems to have been ably, but too secretly devised by the Khedive, it rather unfortunately fell through, we think on account of the jealousy of the Sultan of Zanzibar and his friends. There is no talk by the Khedive of a railway, and we think with the *Times* correspondent, that something more elementary should be attempted, with a country so totally undeveloped as that of Africa. That it will be opened to trade soon by some nation is evident. English, Germans, Italians, French, Portuguese, are all striving from various points. There is plenty of room for all.

A LARGE amount of material for arriving at some approximately correct notion of the mean depth of the sea, has accumulated in recent years. In a note to the Göttingen Academy, Dr. Krümmel has lately attempted this, in view of the vague and variable statements on the subject in text-books. Soundings were wanting for the Antarctic and a part of the North Polar Sea, *i.e.*, about 475,000 square miles, or 7 per cent. of the entire sea-surface, so that he gives his estimate only as a closer approximation. He estimates, then, the mean depth of the sea as 1,877 fathoms, or 3,432 metres, or 0·4624 geographical miles. It was natural to compare the mean height of dry land above the sea-level. Humboldt's estimate of 308 metres is regarded as quite out of date. Leipoldt has since estimated the mean height of Europe as 300 metres. Accepting this number for Europe, 500 for Asia and Africa, 330 for America, and 250 for

Australia, Dr. Krümmel obtains the mean of 420 metres, or 0·566 miles. The surface-ratio of land to water being considered 1 : 2.75, the volume of all dry land above the sea-level is inferred to be 140,086 cubic miles, and the volume of the sea 3,138,000 cubic miles. Thus the ratio of the volumes of land and water is 1 : 22·4. That is, the continents, so far as they are above the sea-level, might be contained 22·4 times over in the sea-basin. Reckoning, however, the mass of solid land from the level of the sea-bottom, the former would be contained only 2·443 times in the sea-space. Dr. Krümmel also compares the masses (taking recent data); he finds that of the sea 3,229,700 cubic miles, and that of the solid land 3,211,310 (a small difference). If the specific gravity of the land were raised merely from 2·5 to 2·51432, we should thus have perfect equilibrium. Such equilibrium is probably the fact.

NEWS has been received from Moscow that Colonel Grodekoff, of the Russian general staff, has returned to that place from a somewhat venturesome expedition in Central Asia, during which he travelled in European clothes, and without any attempt at disguise. He was accompanied by a Kirghiz and two Persians, and traversed the northern part of Afghanistan, reaching Persia by way of Herat.

IN connection with the Russian scheme for a railway from Orenburg to Tashkent, it is stated that the Grand Duke Nicholas is preparing a third expedition for 1879, which is to set out in the end of March. After having passed Tashkent and Samarkand, it will cross the Amu and pursue its researches to the defile of Bamian, in Afghanistan, in the direction of Kabul. The explorers will then descend the Amu in a native boat, from the meridian of Balkh to Khiva, for the purpose of investigating the navigation of that river. From Khiva they will follow the ancient bed of the river to its old mouth in the Caspian.

CAPT. HOWGATE has presented to the United States Congress a supplementary note on the advantages arising from the creation of a polar colony on the border of the great palæocrystic ocean. The whaling interest is fast on the decrease in the States; the total value of imports being only two million dollars instead of ten millions twenty years ago. This deficit has been attributed by Agassiz and other competent authorities to the whales taking refuge in that almost inaccessible polar basin, to which, by the creation of a civilised station at Lady Franklin Bay, access might be gained.

THE Conference on the civilisation of Africa held a meeting recently at Brussels under the presidency of the King of the Belgians. It is stated that Mr. Stanley, who was present, "will be placed at the head of the approaching Belgian Exploring Expedition to Africa."

PETERMANN'S *Mittheilungen* for February contains a detailed account, with map, of Dr. Woeikoff's travels through central and southern Japan in 1878. In connection with a narrative of the discovery of the island Einsamkeit to the north-east of Novaya Zemlya is a map of the island showing its configuration and relative position. Prof. Hann contributes a short paper on the climate at the Victoria Nyanza on the basis of data collected by Dr. Emin Bey and the Rev. Mr. Wilson.

THE January number of the *Bolletino* of the Italian Geographical Society contains a long letter from Lieut. Bové, who accompanies Nordenskjöld's expedition; it was written from the mouth of the Lena, and gives many important details of observations made up to that point.

THE December *Bulletin* of the Paris Geographical Society contains a valuable sketch of the work done in Sumatra by the Dutch expedition, which started in the beginning of 1877 under the late M. Santwoort, and of which we have from time to time given news. The sketch is by Col. Venteggio. The number contains also the addresses by M. Huber in presenting the medals for 1878 to Mr. Stanley, M. Vivien de St. Martin, and Dr. Harmand.

A YOUNG Austrian painter, Herr Joseph Ladein, of Mödling near Vienna, has recently started for a tour through Central Africa. In a letter dated from Oran he states that his intention is to proceed through Marocco, to cross the Great Desert to the Senegal River, then to turn eastward to Haussa and the Nile Lakes, and to return to Europe along the course of the Nile.

A BRANCH of the new Berlin "Society for Commercial Geography and the furtherance of German Interests Abroad" has been established at Leipzig.

M. L. BABÉ has announced to the Paris Geographical Society that he proposes to explore the globe by means of an improved Montgolfier balloon, capable of storing heat in all regions and of maintaining a sufficient height for several weeks.

BAD news has been received from Zanzibar by the French Geographical Society. It appears that two of the French missionaries who were exploring this part of Africa have died, one of them by illness, and the other having been killed by a lion.

NOTES

AT a full meeting of the Council of the Zoological Society, held on the 5th inst. at the Society's office, in Hanover Square, Prof. William Henry Flower, F.R.S., Conservator of the Museum of the Royal College of Surgeons, was unanimously elected president of the Society, in succession to the late Marquis of Tweeddale. The new president, who, we need hardly inform the readers of NATURE, is one of the most learned zoologists and anatomists of the present day, has been for some years on the Council of the Society and one of its vice-presidents, and has communicated many valuable memoirs to its *Transactions* and *Proceedings*. Prof. Flower is the seventh president elected since the foundation of the Society in 1826. Sir Stamford Raffles, the first president, who died a few months after the foundation of the Society, was succeeded by the Marquis of Lansdowne, who resigned in February, 1831, in favour of the thirteenth Earl of Derby, then Lord Stanley. He held the presidentship for upwards of twenty years, and on his death, in 1851, was succeeded by the late Prince Consort. On the death of the Prince Consort, in 1861, Sir George Clerk, of Penicuik, was chosen as his successor, and retained the presidentship until his death, in 1867. He was succeeded in January, 1868, by the late Lord Tweeddale, then Viscount Walden, whose death has caused the vacancy to which Prof. Flower has succeeded.

THE Chemical Society have received from the executors of the late Mr. Sydney Ellis a legacy of 1,000*l*. free of duty.

THE friends of Prof. Clifford, who has been compelled by ill health to relinquish active work and reside in Madeira, are anxious to present him with a substantial testimonial in public recognition of his great scientific and literary attainments. At a meeting held at the Royal Institution, Albemarle Street, on Friday, January 31, Dr. William Spottiswoode, President of the Royal Society, in the chair, it was resolved that a fund should be raised for the above-mentioned purpose, and that the sums received should be placed in the hands of trustees, for the benefit of Prof. Clifford and his family. Contributions may be paid to the account of the "Clifford Testimonial Fund," with Messrs. Robarts, Lubbock, and Co., or to either of the Honorary Secretaries. Among the gentlemen who have kindly consented to act on the General Committee are the following:—Dr. William Spottiswoode, Dr. Andrew Clark, Prof. R. B. Clifton, F.R.S., Prof. T. H. Huxley, Prof. Henry Morley, Prof. A. Newton, F.R.S., Sir Fred. Pollock, Bart., Prof. Roscoe, F.R.S., Prof. H. J. S. Smith, F.R.S., Hon. Mr. Justice Stephen, Sir Henry

Thompson, Prof. John Tyndall, D.C.L., F.R.S., Prof. Alex. W. Williamson, Ph.D., F.R.S. Dr. William Spottiswoode, Pres. Roy. Soc., and Sir John Lubbock, Bart., M.P., F.R.S., are Joint Hon. Treasurers and Trustees.

A GRANT of 75*l*. has been made from the Worts (Cambridge) Travelling Scholars' Fund to John Edward Marr, B.A., St. John's, to enable him to travel in Bohemia and collect evidence and specimens bearing upon the question of the classification of the Cambrian and Silurian rocks, with the understanding that specimens be sent by him to the University, accompanied by reports which may be hereafter published.

WE have already referred to the fact that the inhabitants of Heilbronn, desirous of paying due respect to the memory of Dr. Julius Robert Mayer, who was born there, have resolved to erect a suitable memorial on the spot where he lived, laboured, and died. They invite co-operation, and, with the view of enabling the admirers of Dr. Mayer in England to join in this tribute of recognition, some of the most eminent men of science in England have agreed to form a Mayer-Memorial Committee; the list is headed by Dr. William Spottiswoode, Pres. R.S. Subscriptions exceeding 1*l*. may be sent by cheque to Messrs. Robarts, Lubbock, and Co., 15, Lombard Street. Smaller sums may be sent by Post Office Order to the Hon. Secretary, T. Archer Hirst, Royal Naval College, Greenwich.

M. LÉON LALANNE, Director of the School of Ponts et Chaussées, has been elected to fill the place of the late M. Bienaymé, in the Paris Academy of Sciences.

WE are glad to see that several important and much-needed reforms are being introduced into the British Museum. The Museum is now open free to the public on every week day—Monday till Friday from 10 o'clock, and on Saturday from 12 o'clock till the ordinary hour of closure. Special arrangements have been made to enable students to carry on their work without interruption. Students of natural history will have Tuesday and Thursday reserved for their studies, students of archæology Wednesday and Friday. On Monday and Saturday the public will be able to view the whole of the collections; on Tuesday and Thursday, all except the natural history specimens; and on Wednesday and Friday, all except the Greek and Roman sculptures, and antiquities in the upper gallery. Persons holding tickets of admission to the reading-room, the department of prints and drawings, the sculpture galleries, and the departments of natural history will not be required to renew them every six months, as the tickets will be granted to readers and students without limit of term, but subject to withdrawal. The actual presentation of the ticket will not be considered necessary for entrance into the reading-room. These and several other new arrangements seem to show that the Museum powers have at last come to the conclusion that the institution exists for the benefit of the public, and that their convenience ought to be made paramount in all arrangements.

THE obituary list of foreign men of science is heavy this week. We much regret to announce the death, on January 24, of Dr. Heinrich Geissler, the celebrated inventor in the field of physical mechanics. Dr. Geissler died at Bonn at the age of sixty-five years. Amongst his inventions are the well-known Geissler tubes, the vaporimeter, the mercury-pump, &c. We regret to have to record the deaths of two other eminent German men of science, viz., that of Dr. Eduard Lösche, Professor of Physics at the Royal Polytechnic Institution of Dresden, and well known naturalist, who died on January 25, aged fifty-eight; and that of Dr. Benedikt Stilling, of Cassel, whose name was but recently mentioned as one of the hon. secretaries at last year's meeting of the German Association. Dr. Stilling was an eminent anatomist; he was born at Kirchheim, near Marburg, on February 22, 1810, and died at the same place on January 28, aged sixty-nine years. The death is announced of Dr. Steinheil, the eminent optician of Munich. M. Paul Gervais, the distinguished palæontologist and Professor at the Paris Jardin des Plantes, died on Monday in his sixty-third year.

Apropos of the statue to Gauss, the following extracts from a Brunswick correspondent may interest some of the readers of NATURE. The sum collected, including contributions of 3,000 marks each from the Emperor of Germany and the Duke of Brunswick, promised subscriptions and interests, has now reached 41,000 marks. Herr Schaper has almost, if he has not quite, finished the statue; the casting in bronze is then to be superintended by Prof. Howaldt of Brunswick. A Berlin firm will provide the pedestal of red granite from Sweden. The statue will be one and a half life size, standing eight feet four inches (Rhenish measure), and the pedestal will be of about the same height. It is hoped that the unveiling of the statue will take place on April 30, 1880—the anniversary of Gauss's birth.

A CONCURRENT resolution of thanks to Prof. Hayden for his "accurate and comprehensive survey of the State of Colorado" passed the Colorado legislature, January 14. Senator Gaussion, who is himself an eminent mining engineer, remarked—"These reports, coming from a scientific and authoritative source, do more to answer and satisfy the inquiries of capitalists than everything else. They tell the world what the great western country is made of. The western domain of the United States is to-day the glory of the nation."

WE are asked to state that supplemental meetings, for the reading and discussion of papers by students of the Institution of Civil Engineers, have been appointed for the following Friday evenings:—February 14, 21, 28, and March 7. The papers to be read on these evenings are respectively: "The Excavating of a Tunnel in Rock by Hand Labour and by Machinery," by John C. Mackay: "The Design and Construction of Wrought-Iron Tied Arches," by Percy W. Britton; "The Cost and Construction of a Cheap Light Railway," by Alfred W. Szlumper; and "The Interlocking of Points and Signals and the Electric Block System," by George D. Marston. The chair will be taken at 7 o'clock on each evening, and successively by Mr. Hayter, Mr. Barlow, F.R.S., Mr. Bruce, and Mr. Woods, Members of Council.

SOME recent experiments by Herr Holmgren in Prof. Kühne's laboratory in Heidelberg seem to prove that the variations of the retina current through the action of light have no essential relation to the blanching and regeneration of the so-called "visual purple," thus increasing the difficulty of regarding that purple as directly connected with vision. In one experiment an eye of a newly killed frog was kept half an hour to an hour in sunlight, till all the visual purple was blanched. Variations of the retina current on incidence of light were found to occur in the ordinary way. Again, one eye of a rabbit was protected against the action of light by sewing the ear over it, while the other eye was exposed to the light. The animal showed normal variations of the retina current, and when the eyes were examined, with the necessary precautions, the normal amount of purple was found in the covered eye, while the other, which gave variations of the current, was quite without purple. Conversely, eyes of frogs and rabbits were taken out and treated with alum solution in the dark. The visual purple was thus maintained twenty-four hours, and it was then exposed to light. The light blanched it, like that of a fresh eye, but there was no trace of variation of current in consequence of this action. The author's conclusion regarding vision finds support in the facts that visual purple is wanting in some animals, which must be supposed capable of sight, and that it is absent from the yellow spot in man, and so from that part of the retina in which vision is most distinct.

IN a recent series of demonstrations at La Salpêtrière, Paris, Prof. Charcot has shown, *inter alia*, that it is possible to produce in one subject a state of catalepsy on one side of the body, and a simultaneous state of lethargy on the other. The patient is first thrown into catalepsy by looking at the electric light (in this state the limbs are supple and will retain any position one chooses to give them). To produce the state of lethargy or somnambulism on one side, it is sufficient to close the corresponding eye, or shut off the light with a screen; the two states are then co-existent on the two sides of the body.

WE learn from the *North China Herald* that at the December meeting of the Shanghai branch of the Royal Asiatic Society, a paper was read by M. A. A. Fauvel, on the alligators of China, on which occasion the author exhibited a live specimen obtained last October from Chinkiang, on the Yangtsze-kiang, as well as a cranium and skeleton, and a stuffed crocodile for comparison. The paper commenced with a philological dissertation on the names by which the saurians of China have been known at various times, and the specimen exhibited (between 5 and 6 feet long) was identified with the *t'o* or *ngo* of the old writers. Among modern writers, the late Mr. Swinhoe seems to have been the first to allude to its existence, and in 1869 a specimen was exhibited in the Chinese city of Shanghai. Père Heude more recently nearly became the possessor of a specimen which he only lost through his servant haggling over the price. At various times reports have reached Shanghai of crocodile-like animals being seen in the Yangtsze-kiang, but Mr. L. E. Palm, of the Chinese Customs' service, was the first to obtain a genuine specimen, which was presented to the Society last year. A careful examination soon showed, according to M. Fauvel, "that it was no crocodile, but a genuine alligator, a most interesting fact, as hitherto no alligator has been met with in the Old World, the genus being supposed to be confined to the rivers of America." M. Fauvel then explained from the specimens, and by means of careful drawings, the peculiarities of the genus. The Chinese animal seemed to resemble most the *Alligator lucius* of the Mississippi, but, as it seemed to belong to a distinct species, he proposed for it the specific title of "*sinensis*," until further research should establish or disprove the distinction.

THE *North China Herald* publishes some notes of a journey made during last October by the Rev. J. S. Crossette, in the northern part of the Chinese province of Shantung, in the course of which he visited a cotton-growing district. His account of this industry is not very encouraging. The scraggy little shrub, he writes, not as high as the knee, black as if blasted by mildew or killed by frost, looks very different from that in the cotton-fields of the United States; and in his opinion the introduction of some foreign cotton-seed would effect a great improvement.

ACCORDING to the *Democrat*, San Francisco is to be the first city whose streets are to be lighted entirely by the electric light. It is proposed to divide the city into districts, varying in extent from one to three miles, each of which will be fed by a sufficiently powerful Gramme machine. The machines have already arrived at New York, and arrangements have been made for adopting two or three different patents. The *Electrician* says:—"The experimental trial of the electric light at the works being executed at the port of Havre has given complete satisfaction. Without waiting for the report of the committee nominated by the French Board of Works, the Chamber of Commerce has authorised the establishment of ten lights in the outer port."

IN his last report to the Foreign Office, H.M.'s Consul at Tamsui, Formosa, calls attention to one or two features of interest in connection with the camphor trade there, which is assuming considerable proportions. Formosa, it is well known, is one of the very few districts in the world which produce camphor, the others being Japan and some parts of the Malay Archipelago. The tree from which it is obtained (*Camphora officinarum*), is said not to be known on the mainland of China; camphor, at any rate, is not extracted from it there. The camphor-producing tree of the Malay Archipelago differs from that growing in Formosa and Japan, and, in addition to the crude camphor, produces a valuable medicinal gum, known to merchants as "camphor baroos," the duty on which in China is about 6*s*. per pound. The Formosan tree, on the contrary, does not produce this gum.

As showing the much greater attention gradually being directed to Singapore and the Malay Peninsula, to which we have from time to time alluded, it will not be uninteresting to record that some land at Tanjong Pagar, which, not a great number of years ago, was bought from the East India Company at the rate of 1 rupee for fifteen acres, was recently sold at prices ranging from 20,000 dols. to 30,000 dols. per acre.

OWING to the melting of mountain snows and torrential rains, the Lake of Geneva reached a higher level last month than it has been known to attain at this season in the forty-one years during which its fluctuations have been noticed.

IT is rumoured that M. Ferdinand de Lesseps will be appointed Governor-General of Algeria.

M. MAURICE SAND has discovered and published an account of a "pre-historic flint-implement workshop" near the village of Loges, on the frontier of the Indre and the Cher. On the summit of a heath, almost on a level with the surface, he has picked up hundreds of fragments of flints, convex on one side, concave on the other; also lanceolated axe-heads, arrow-heads, a jasper axe, and many scrapers in red and white cornelian or sardonyx. The flint-layers cropping out to the surface bear marks of human labour.

THE collection of maps, plans, and views of London and Westminster, made by the late Mr. Frederick Crace, and lent to the South Kensington Museum by his son, Mr. J. G. Crace, is now on view from 10 to 4 daily, in two of the upper rooms in the galleries on the west side of the Horticultural Gardens. The plans and views selected from the collection for exhibition are 3,085 in number. A complete catalogue, compiled from Mr. Crace's larger work, has been issued by the Stationary Office.

NEW GUINEA is rapidly ceasing to be *terra incognita*. Thanks to both scientific and missionary enterprise we have lately learnt much both of its geography and ethnology. Recently, and in this country alone we have had the results of the experience of D'Albertis, Comrie, Kiehl, Lawes, Moresby, and Turner. In the *Chronicle of the London Missionary Society*, October, 1878, we have, under the title "New Guinea," an account of the journeys made by the Rev. Jas. Chalmers. He is stated to have visited one hundred and five villages on the south coast of the mainland during the spring of last year, and ninety of these villages are reported as being visited for the first time by a white man. From Mr. Chalmers's general ethnological notes we learn that these natives cook the heads of their slain enemies to secure clean skulls to place on sacred places. Each family has a sacred place where offerings are carried to the spirits of deceased ancestors. This ancestor worship seems to be carried on with great fear. The spirits of their dead are invoked at the commencement of planting, at starting on trading expeditions, &c. They have one great spirit—Palaku Bara, who dwells in the mountains. Pigs are always killed in the sacred place and offered to the spirit, after which the carcase is carried back to the village to be divided and eaten. During this expe-

dition the entire coast line from Keppel Point to McFarlane Harbour was traversed on foot.

PERHAPS no branch of anthropology has been more cultivated or yielded larger results during the last few years than that relating to prehistoric man. At the same time no inconsiderable part of the evidence has been derived from the examination of osseous and other remains in caves both in England and on the continent. The greatest interest has always been felt in the revelations that might accrue to the science of anthropology by an investigation of the bone-caves of Borneo, situated as that island is on the confines of the lost continent Lemuria, where Dr. Peschel thinks it possible that the first appearance of man may have taken place. In his late presidential address to the Anthropological Institute, Mr. Evans referred to the fact that Mr. Everett, a well-known naturalist, had undertaken to devote a twelvemonth to the prosecution of cave-researches in Borneo. Mr. Everett commenced his researches in October last, and the principal proceeds from more or less extensive excavations in several caves are now on their way to this country. Mr. Everett's first quarterly report had just been received by Mr. Evans, in which the discovery is reported of numerous mammalian remains, the age of which has still, of course, to be determined, and also of remains of a race of men of whom no local tradition seems to be extant, and who habitually used the caves of Upper Sarâwak either as domiciles, or as places of sepulture, or possibly for other purposes. Though unknown to history or tradition, this race of men appear to have been acquainted with the use of manufactured iron, so that, probably, no great antiquity is to be assigned to the remains already discovered. Mr. Evans stated that at least 100*l.* has still to be forthcoming for the exploration fund, in addition to what has been already subscribed, and that he would be happy to receive subscriptions.

THE magnetic behaviour of iron in the form of powder has lately been investigated by Prof. von Waltenhofen, of Prague. Three samples of finely pulverised and chemically pure iron, filling well-closed glass tubes, were magnetised by means of spirals of wire, through which were sent currents of increasing intensity, and the magnetic moments thus produced were measured. A comparison of these with those excited in equally heavy iron and steel bars by equal magnetising forces shows that the specific magnetisability of pulverised iron is not only much smaller than that of coherent iron, but even smaller than that of the hardest kind of steel known, viz., glass-hard Wolfram steel. Prof. Waltenhofen seeks an explanation of this in the circumstance that the magnetic mutual action of the polar molecules, which strengthens the action of exterior magnetising forces, is greatly lessened through the comparatively great intervals between the particles of the powdered iron; and the numbers he obtained led him to the conclusion that the electro-magnetism of an iron bar is to be regarded only in the least part as due to direct action of the magnetising current, and mainly due to that reciprocal action of the molecular magnets.

IN his ninth Bridgewater treatise, Mr. Babbage refers to the possibility of constructing an automaton which would play the simple game of tit-tat-to (or "oughts and crosses"). Such a machine (probably the first ever constructed), working on the principle of a mechanical table, has been made by Mr. Freeland of Philadelphia. It is described in the January number of the *Journal of the Franklin Institute*, and was exhibited at the Institute on October 16 last year. It is now at the University of Pennsylvania, where, since its final adjustment, it has played a large number of games without losing a single one.

EARTHQUAKES are reported from Waldkirch and Buchholz, in Baden, on January 26, at 10 P.M. Both villages are situated in the Elz Valley, on the slopes of the Kandel Mountain, which measures 1,380 metres in height. A violent shock was also felt in the Swiss Canton of Uri on January 24, at 2 A.M.

THE Italian Secretary for Agriculture, Industry, and Commerce, has offered a prize of 3,000 lire (about 115*l.*) for the best monograph on the cultivation, growth, and diseases of the species *citrus* (the common lemon-tree). The competition will last until May, 1881, and all particulars may be learnt direct from the Secretary's office at Rome.

A VERY satisfactory Report comes to us from the Free Library Committee of Dundee. Under the care of Mr. Maclachlan, the library, in the quality of its contents and its organisation, is becoming one of the first of the kind in the kingdom, and is evidently well appreciated by the busy and inquisitive workers of Dundee. Scientific works have a large share of attention, and the museum, we are glad to see, is rapidly extending, and is likely ere long to be worthy of one of our great commercial centres. We have received a carefully compiled fourth supplement to the catalogue of the Library.

THE additions to the Zoological Society's Gardens during the past week include two Slender Loris (*Loris gracilis*) from Ceylon, presented by Mr. Leith Bonhâte; a Common Rhea (*Rhea americana*) from South America, presented by Major Venables; a Purple-crested Touracou (*Corythaix porphyreolopha*) from East Africa, presented by the Rev. J. A. Gould; a Geoffroy's Dove (*Peristera geoffroii*), bred in the Gardens.

OXYGEN IN THE SUN[1]

THE paper referred to appeared in the October number of this Journal.[2] A cursory glance at it gives the impression that the methods had been carefully criticised beforehand, that the experiments had been made with minute accuracy and that the results were trustworthy; but closer examination of it raises most serious questions on all the points mentioned. Errors of method and of experiment appear which make it quite impossible to accept the conclusions reached. It is the purpose of this note to point out some of these.

In the first place the author throughout the paper confounds Ångström's scale numbers with wave-lengths. Thus, for example, p. 257, he says, line 18, the photographs were "in sections of eighty to one hundred wave-lengths," line 24, "each wave-length being five millimeters in extent," and line 34, "each section of one hundred or more wave-lengths;" p. 258, line 24, "Error amounting to half a wave-length could therefore exist in the position of a line, according as it fell on one side or the other of a figure on the scale expressing a wave-length;" p. 259, line 18, one iron line "to every eleven wave-lengths was used;" p. 261, line 18, no element gives "a line within two or three-tenths of a wave-length of that position;" p. 264, line 16, "no other element furnishes a line which falls on the same wave-length." In proof that he really means scale divisions, he gives a section of his chart on p. 259, and says, line 38, "On the first space below the line is the scale of wave-lengths, each wave-length being five millimeters in extent;" and p. 260, line 28, "in the eighteen wave-lengths represented in the diagram." There are eighteen scale divisions in the diagram, each scale division being five millimeters long. Again, p. 264, referring to the coincidence of oxygen and solar lines in his table, he says, line 2, "in four, the difference is only five one-hundredths of a wave-length; in twenty-two, ten one-hundredths of a wave-length; in four, fifteen one-hundredths of a wave-length; in eleven, twenty-one one-hundredths of a wave-length; and in the remainder, the greatest difference is only thirty-five one-hundredths of a wave-length." Referring to the table, the four lines first mentioned are given as 3982·75, 4075·50, 4345·15, and 4483·80; the corresponding oxygen lines being given as 3982·70, 4075·45, 4345·20, and 4483·75. The difference is obviously five one-hundredths of a scale division, not of a wave-

[1] Note on J. C. Draper's paper "On the Presence of Dark Lines in the Solar Spectrum which correspond closely to the Lines of the Spectrum of Oxygen." From the *American Journal of Science* for February. Communicated by the Author.

[2] See NATURE, vol. xviii. p. 654.

length. From the fact that this error runs through the entire paper, it would almost seem as if the author was not aware of the distinction between wave-lengths and scale numbers. Using Ångström's scale he confuses wave-lengths with ten millionths of a millimeter; whereas in the case of D for example, the wave-length is nearly 6,000 times greater. If the author really means what he says, he asserts that the wave-length of the mean ray of the spectrum is one two-hundred and fifty-millionth of an inch instead of about one forty-thousandth, as we know it is.

Second, the author deems it of the greatest importance in the preparation of his solar photographs to use reflected rays exclusively; saying, p. 256, last line, "*at no time did the solar rays pass through glass*; all error that might arise during refraction was thus avoided." After this virtual condemnation of the use of refraction at all, he not only uses for comparison Ångström's wave-lengths made with achromatic lenses and a refracting grating, constructing even his chart upon them as a basis, p. 258, line 7, "the values assigned to the wave-lengths in this chart are those of Ångström"; but the very spectrum of oxygen by which the coincidence of the lines of this element with those of the sun spectrum were to be established, was photographed with glass prisms and achromatic lenses.

Third, the author states that the prisms with which the spectrum of oxygen was photographed were adjusted "to the minimum deviation of D′." Supposing D_1 to be meant, this precaution, which gives the appearance of extraordinary accuracy to the adjustment, is practically an impossibility with the apparatus employed. Minimum deviation of the D line as a whole could not under these circumstances be distinguished from that of either of its components, nor could that of D_1 be distinguished from that of D_2. Moreover, it is difficult to understand why he adjusts to minimum deviation for D′ and not for G, near which the work is to be done. Instead of D′, the line for which his apparatus was adjusted should have been chosen in the photographic portion of the spectrum, for example between G and H.

Fourth, on page 265, line 25, the author says that this "is a problem not to be solved by the comparison of two spectra of small dispersion." Hence it is a matter of some surprise to find that in getting his oxygen spectrum, he uses only "two flint glass prisms of 60," and for objectives, "achromatics of ten inches focus." The bright line spectrum of oxygen taken by Henry Draper, which the author in this paper inferentially attacks, was made, as we find on examination, with a direct vision battery of nine prisms and an observing telescope of forty-two inches focal length. The original negatives taken with the latter apparatus must consequently have been eight or nine times as long as the author's; and even these were none too large for the proper solution of the question.

Fifth, the author seems to have attempted to compare together a diffraction spectrum of the sun with a prismatic spectrum of oxygen. Such a comparison, by the method adopted, is manifestly of no value. Owing to the irrationality of dispersion of various refractive media it is an extremely difficult thing to compare accurately two prismatic spectra of different kinds. But the matter rises to an absurdity when a comparison is attempted between a grating spectrum and a prism spectrum. The graphic method, employed to supplement the direct method, does not appear to help the comparison, since the author nowhere gives both co-ordinates to the curve constructed.

Sixth, it is more than questionable whether the measurements of the solar lines actually made by the author are capable of the accuracy he assigns to them. The values in his table of wave-lengths are given to one hundredth of a division of Ångström's scale. As the author says on p. 257 that each division of this scale, which is one millimeter, was enlarged to five millimeters upon the paper scale on which the photographs were projected, to measure to one hundredth of a scale-division would require the measurements on the screen to be made to one-twentieth of a millimeter or the one five-hundredth of an inch, about; a degree of refinement highly improbable under these conditions. Moreover the accuracy of the results of such measurements is seriously impaired by the variation in the position of the lines on the screen, due to the fact that the large number of negatives (eight or nine apparently), required to give the whole photographic spectrum, must, unless special precaution was taken (of which there is no evidence), have been made with glass of different thicknesses. When projected in the lantern, this variation in thickness would necessitate a change in focus and so cause a change in the magnifying power. The smaller sizes of photographic glass vary in thickness from one to two millimeters. Consequently the displacement of the lines due to the difference of magnifying power arising from this cause would exceed considerably the limit of measurement, which, as above stated, was the one five-hundredth of an inch. But another and a more serious cause of inaccuracy must here be pointed out. From the data given by the author, it may readily be calculated that his original photographs of the oxygen spectrum, taken with two prisms of 60° and with lenses of ten inches focus, could not have been over half an inch long in the region from G to H. Since Ångström's chart from G to H is sixteen inches long, the author's spectrum would have to be magnified thirty-two times to make it the size of this. But as each millimeter of Ångström's scale was made five millimeters on the author's scale of measurement, the original negative as thrown on the screen must have been magnified one hundred and sixty diameters. Any one who has worked at all in spectrum photography, knows that it is utterly futile for purposes of measurement to magnify a photograph taken under these circumstances, as much as this, since then the size of the silver grains becomes larger than the details of the picture. In the absence of any precise statement the reader has to make the calculation for himself; but the figures above given cannot be far astray.

Seventh, there is only an appearance of accuracy when the attempt is made to fix the position of the oxygen spectrum lines to hundredths of one of Ångström's scale divisions. The projection method by which his solar lines were measured, has already been proved inadequate. And as to the method of graphical interpolation, used as auxiliary to the lantern, it does not appear that, as used by the author, it was capable of any such accuracy as that claimed. In constructing the curve, the iron lines are taken with Ångström's values for the wave-lengths; but these, though estimated to tenths, were read only to whole divisions of the scale. Moreover, only forty-seven iron lines were used in all, or one to every eleven scale divisions; the reading being to one one-hundredth of a scale division, or 1,100 numbers to one iron line. Since the author measured no wave-lengths directly, he was obliged to construct a considerable "portion of the curve from the wave-lengths of oxygen and air lines already given by various authorities." These values were taken, p. 258, from Watt's "Index of Spectra." On referring to this book, the values are given only to the units place. And even then, discrepancies amounting to from three to five entire units, or from three hundred to five hundred times the author's limit, appear in the wave-length as given by the various authors relied on for the measurements employed in the paper before us.

Eighth, the author nowhere states the peculiar character of the lines in the oxygen spectrum and appears not to know that they have any. He has apparently taken it for granted that the lines of oxygen are intrinsically as sharp as the lines of the solar spectrum. But this, at least in many instances, is known not to be the case. Consequently it is quite impossible to measure the oxygen lines as accurately as the solar lines, and even these, as has been shown, cannot be measured to the accuracy which the author claims. Ångström himself admits that there may be an error of one-tenth of a division in his scale numbers.

It would seem sufficiently obvious from what has been said that the results given in this paper are entirely vitiated by the errors of method and of experiment which it contains. The author must not be confounded, because of the similarity of initials, with the distinguished investigator, Dr. J. W. Draper.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

UNIVERSITY education for women may be taken as firmly established in England. The names of nine out of eleven female candidates have just been posted at Burlington Gardens as having passed the winter matriculation examination of the University of London, half-a-dozen in the honours division, besides three more in that next below, and are thus now on the high road to its B.A. degree, on the occasion of its first decorating their sex three academical years hence. From two interesting articles in the *Daily News* it is seen that Girton and Newnham Colleges have attained to unexpected success. The former is so much too small for the number of students that yearly flock to it that it is to be nearly doubled in size. At both institutions the students work much more earnestly than the average student of the hitherto privileged sex, and the examinations passed, at least at Girton, would

suffice to give the most successful student a high place in the Cambridge list of Wranglers. No doubt, in the near future, English girls all over the land will have as few obstacles in the way of their higher education as English boys.

MR. H. T. WOOD, of the Society of Arts, writing to Col. Donnelly, of the Science and Art Department, South Kensington, informs him that sufficient funds will be provided by the City Companies for the payment of teachers of classes for instruction in technology, on the same scale as that on which teachers of science classes are now paid by the Science and Art Department, and without any proportionate reduction, as stated in the Society's Programme of Examinations (p. 14), on the ground that all the amount at the disposal of the Society might be insufficient to allow of the full payment in all cases. Mr. Wood asks that this important fact be brought under the notice of the Secretaries of Science Classes and Schools. The arrangement will apply to the examinations held in May next.

DR. T. LAUDER BRUNTON, who was recently appointed to the Thomson Lectureship in the Aberdeen Free Church College, delivered the opening lecture on Monday, the 3rd inst. The course will consist of ten lectures.

THE University Library at Strassburg, founded after the recent Franco-German War, numbered no less than 470,000 volumes at the end of 1878.

WE are glad to see that in the second number of the *University College of Wales Magazine* science finds a corner in the shape of "Museum Notes." One of these, by Prof. Rudler, is a brief *résumé* of what is known of the Moa, *apropos* of a collection of moa-bones in the College Museum.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, January.—The error of some wild statements made about the size and cost of the cable that would be needed to convey the power of Niagara Falls several hundred miles by electricity is here shown by Professors Thomson and Huston, who calculate, *e.g.*, that 1,500 to 3,000 horse-power could be conveyed 1,000 miles (50 per cent. out of 3,000 horse-power) with a copper cable about ½ inch in thickness. Less than ⅓ inch would suffice for 500 m. For consumption of 1,000,000 horse-power a 3-inch cable would suffice. The same authors describe a curious thermo-magnetic motor, and an induction apparatus for reversed currents.—Dr. Henry Morton finds the coating of the "luminous clocks" sulphide of calcium attached with some resinous medium, and seems hopeful that advances in this direction may by and by give us houses lit at night by phosphorescent walls.—Mr. Huston gets some remarkable effects (needing confirmation from repeated tests) in subjecting iron to a continued and constantly increasing strain.—Dr. Dudley considers toughness, rather than hardness, the essential quality for durability of steel rails.—An automatic machine for playing the game of tit-tat-to is described by Mr. Freeland.

Reale Istituto Lombardo di Scienze e Lettere, vol. xi. fasc. xix., xx.—On some derivatives of ethyl-paraoxybenzoic aldehyde, by S. Corbetta.—The English sanitary laws, by Dr. Zucchi.—On the use of salts of berberine as febrifuge, and on tumours of the spleen from malarian infection, by Dr. Zucchi.—Studies on milk at the Pavian laboratory of cryptogamic botany, by Drs. Pirotta and Riboni.—Value of two meteorological instruments of Bellani, by Prof. Cantoni.—Observations on the seismic microphone of De Rossi, by Prof. Cantoni.

Vol. xii. fasc. i.—Studies on milk (continued), by Drs. Pirotta and Riboni.—New physio-pathological researches on pulmonary phthisis, by Prof. de Giovanni.—First lines of introduction to the study of the Italian bacteria, by S. Trevisan.—On modular equations, by S. Klein.—On pentahedral equations of surfaces of the third order, by Prof. Beltrami.

Bulletin de l'Académie Royale de Belgique, No. 11, 1878.—Besides M. Montigny's paper on variations in the scintillation of stars (referred to last week), this number contains a valuable memoir by M. Fredericq on the organisation and physiology of the poulpe (or octopus), which he studied at the laboratory of Roscoff. The arterial blood yields a blue colouring matter (called *hæmocyanine*), which corresponds somewhat to hæmoglobin, but contains copper, not iron. Both respiration and nutrition of tissues depend on it. The heart has both accelerating and moderating nerves. The blood pressure is considerably greater than in cold-blooded vertebrates; the venous system shows rhythmic contraction; exterior water does not mix with the blood; the urine contains neither urea nor uric acid, but a substance like guanine, &c. M. Fredericq localises the centres of the respiratory movements, and gives some interesting observations on the "chromatic function."—M. Van der Mensbrugghe finds confirmation of his theory of the variations of potential energy of liquid surfaces, in some peculiarities of liquid sheets, which he accounts for on thermodynamical principles.—M. Lienard communicates researches on the structure of the digestive apparatus of Mygales and Nephiles, and M. Longchamps concludes his synopsis of the Gomphines.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 30.—"On the Effects of Heat on the Di-iodide of Mercury, HgI_2," by G. F. Rodwell, Science Master, and H. M. Elder, a pupil, in Marlborough College.

The authors, in continuation of experiments of a similar character previously communicated by one of them to the Society, on the anomalous expansion of the iodide of silver, have examined the iodide of mercury with a view to the detection of similar anomalies. This body is dimorphous, existing in the form of yellow prismatic crystals, which change under external mechanical influence, or during the process of cooling, to brilliant scarlet octohedrons with a truncated summit. The mass melts at 200° C. to a red-brown liquid, which volatilizes at a slightly higher temperature. The following volumes were determined at the temperatures given:—

	Volume.		Specific Gravity
Liquid at 200° C.	1·1191147	...	5·286
Solid ,, ,, ...	1·0190453	...	6·179
Yellow prismatic condition at 126° C.	1·0115378	...	6·225
Red octohedral condition at 126° C.	1·0043337	...	6·276
,, ,, ,, at 0° C.	1·0000000	...	6·297

Thus the di-iodide of mercury possesses one coefficient of expansion = ·0000344706 for 1° C. between 0° and 126° C., it then undergoes a sudden expansion = ·00720407 in changing from the red octohedral to the yellow prismatic variety, while between 126° C. and the melting-point (200° C.), it expands under a higher coefficient than before = ·0001002953 for 1° C.

"A Comparison of the Variations of the Diurnal Range of Magnetic Declination as recorded at the Observatories of Kew and Trevandrum." By Balfour Stewart, F.R.S., Professor of Natural Philosophy in Owens College, Manchester, and Morisabro Hiraoka.

1. Generally speaking, maximum points or risings in the one curve must be associated with maximum points or risings in the other, rather than with minimum points or depressions. Indeed, the researches of Broun and others, from a different point of view, strengthen this conclusion, which is, however, abundantly supported by a glance at the curves themselves.

2. The oscillations of the Trevandrum curve are greater than than those of the Kew curve.

3. In many cases where there is a want of striking likeness between the oscillations of the two curves, there are yet noticeable traces in the one curve corresponding to the oscillations of the other. There are, however, a few cases where there is a want of apparent likeness.

4. In general, though not invariably, the oscillations of the Trevandrum curve follow rather than precede the corresponding oscillations of the Kew curve.

February 6.—"Absorption of Gases by Charcoal. Part II. On a new Series of Equivalents or Molecules." By R. Angus Smith, Ph. D., F.R.S.

In the *Transactions* of the British Association, 1868, Norwich, on p. 64 of the "Abstracts," there is a preliminary notice of an investigation into the amount of certain gases absorbed by charcoal. I made the inquiry from a belief previously expressed in a paper of which an abstract is in the *Proceedings* of the Royal Society, p. 425, for 1863. I said in that paper that the action of the gas and charcoal was on the border line between physics and chemistry, and that chemical phenomena were an extension of the physical; also that the gases were absorbed by charcoal in whole volumes, the exceptions in the numbers being supposed to be mistakes. The results given were:—

Hydrogen	1
Oxygen	7·99
Carbonic oxide	6·03
Carbonic acid	22·05
Marsh-gas	10·01
Nitrous oxide	12·90
Sulphurous acid	36·95
Nitrogen	4·27

It was remarked that the number for nitrogen was probably too low; I had some belief that the charcoal retained a certain amount which I had not been able to estimate.

For common air, the number 40·065 crept into the paper or abstract instead of the quotient 7·06.

I considered the numbers very remarkable, but was afraid that they would be of little interest unless they could be brought more easily under the eyes of others; my experiments were somewhat laborious; the exact numbers were seldom approached by the single analysis, but were wholly the result of a series of irregular averages and apparently irregular experiments. The cause of this was clear, as I believed, namely, the irregular character of the charcoal with which I had to deal. The experiments were forgotten, I suppose, by most men, but the late Prof. Graham told me that he had repeated them with the same results that I had published. I might have considered this sufficient, but waited for time to make a still more elaborate investigation of the subject, and to take special care with oxygen, in the belief that, the rule being found, the rest of the inquiry would be easy; this was extended to nitrogen, but not by so many experiments as with oxygen. I am now assured of a sound foundation for inquiries, which must take their beginning from the results here given.

It is found that charcoal absorbs gases in definite volumes, the physical action resembling the chemical.

Calling the volume of hydrogen absorbed 1, the volume of oxygen absorbed is 8. That is, whilst hydrogen unites with eight times its weight of oxygen to constitute water, charcoal absorbs eight times more oxygen by volume than it absorbs hydrogen. No relation by volume has been hitherto found the same as the relation by weight.

The specific gravity of oxygen being 16 times greater than hydrogen, charcoal absorbs 8 times 16, or 128 times more oxygen by weight than it does hydrogen. This is equal to the specific gravity of oxygen squared and divided by two $\frac{16^2}{2}$, or it is the atomic weight and specific gravity multiplied into each other, 16×16, and divided by two $\frac{256}{2} = 128$.

Nitrogen was expected to act in a similar way, but it refused. The average number of the latest inquiry is 4·52, but the difficulty of removing all the nitrogen from charcoal is great, and I suppose the correct number to be 4·66. Taking this one as the weight absorbed, $14 \times 4·66 = 65·3$, or it is $\frac{14^2}{3}$. Oxygen is a dyad; nitrogen a triad.

We have then carbonic acid not divided, but simply 22 squared = 484.

Time is required for full speculation, but the chemist must be surprised at the following:—

Carbonic oxide	6	volumes.	
Carbonic acid, CO_2	6 + 16	,,	= 22.
Marsh-gas, CH_4	6 + 4	,,	= 10.
Protoxide of nitrogen, NO	8 + 4·66 (N) (4·9).		= 12·66.

These four results belong to the early group not corroborated lately, but so remarkably carrying out the principle of volume in this union giving numbers the same as those of weight in chemical union, that they scarcely require to be delayed.

I am not willing to theorise much on the results; it is here sufficient to make a good beginning. We appear to have the formation of a new series of molecules made by squaring our present chemical atoms, and by certain other divisions peculiar to the gases themselves. Or it may be that the larger molecule exists in the free gas, and chemical combination breaks it up. These new and larger molecules may lead us to the understanding of chemical combinations in organic chemistry and whenever there is union not very firm, and may also modify some of our opinions on atomic weights and the motion of gases.

Of course, I cannot pretend to give the result of these results; but as we have here the building up of a molecule by volumes, so as to form an equivalent of physical combination analogous to the chemical equivalent, it is impossible to avoid seeing that it indicates the possibility of our present equivalents being made up in a similar manner.

I did not expect these numbers; but I certainly, as my previous paper showed, had in full view a necessity for some connection between physical and chemical phenomena more decided than we possessed.

Chemical Society, February 6.—Dr. Gladstone, president, in the chair.—This meeting was occupied by the discussion on the processes for determining the organic purity of potable waters, a paper read by Prof. Tidy some time since. Dr. Frankland opened the discussion and criticised at some length the objections urged by Prof. Tidy against his method of estimating the carbon and nitrogen in a water residue by combustion. The discussion was continued by Mr. Wanklyn, Mr. Kingzett, Prof. Bischof, Dr. Voelcker, Mr. Grosjean, Dr. Dupré, Mr. W. Thorp, and Dr. Hake. Prof. Tidy then briefly replied, and the proceedings terminated with a unanimous vote of thanks from a crowded meeting to Prof. Tidy for his paper.

Zoological Society, February 4.—Dr. Günther, F.R.S., vice-president, in the chair.—Mr. Sclater exhibited and made remarks on a specimen of a Curassow, belonging to the Royal Museum of Copenhagen, which he had received from Prof. J. Reinhardt, F.M.Z.S., for examination, and which Prof. Reinhardt had proposed to refer to a new species (*Mitua salvini*).—Mr. R. Bowdler Sharpe exhibited a series of Bulwer's Pheasant (*Lobiophasis bulweri*), from the Lawas River, N.W. Borneo, collected by Mr. W. H. Treacher, Acting-Governor of Labuan. The series represented every stage of plumage of this pheasant, and conclusively proved that *L. castaneicaudatus*, Sharpe, was the immature male of *L. bulweri*.—A communication was read from Prof. A. H. Garrod, F.R.S., containing some notes on certain points in the anatomy of Hoatzin (*Opisthocomus cristatus*).—Mr. Sclater read some notes on the breeding of the Argus Pheasant and other Phasianidæ in the Society's Gardens.—A communication was read from the Rev. O. P. Cambridge, C.M.Z.S., containing the description of a new genus and species of spiders, proposed to be called *Fritzia muelleri*.—Mr. W. Ottley read the first part of a series of observations on the structure of the eye-muscles in the mammalia.—A communication was read from Mr. Osbert Salvin, F.R.S., on some birds transmitted by the Rev. Thomas Powell from the Samoan Islands, amongst which were two new species proposed to be called *Pinarolestes powelli* and *Fregetta mæstissama*.—A communication was read from Mr. W. H. Dale containing remarks on the use of the generic name *Gouldia* in zoology.—Mr. George A. Shaw read notes upon the habits of four species of Lemurs, specimens of which had been brought alive to England in 1878, from the province of Betsileo in Central Madagascar.—A communication was read from Mr. F. Moore, F.Z.S., containing descriptions of some new Asiatic diurnal lepidoptera.—Dr. A. Günther, F.R.S., pointed out the characters of a new rodent from Medellin, U.S. of Columbia, for which the name *Thrinacodus albicauda* was proposed.

Linnean Society, January 16.—Mr. W. Carruthers, F.R.S., vice-president, in the chair.—Prof. Allen Thomson exhibited and made some remarks on a block of wood, during the growth of which a portion of the shank-bone of an ox had become centrally inclosed; he also called attention to an imperfect frond of a palm (Chamærops?) asserted to have been discovered within a plank of rosewood.—Mr. Christy in some observations referred to the Chalmugra tree (*Gynocardia odorata*), its therapeutical properties being highly extolled, especially in rheumatism.—Mr. J. G. Baker read a paper on the Colchicaceæ and aberrant tribes of Liliaceæ. Colchicaceæ is the smallest of the three sub-orders of Liliaceæ, it includes 39 genera and 153 species. Its geographical dispersion agrees completely with true Liliaceæ. In its typical form it is marked by extrorse anthers, a septicidal capsule, and three distinct styles; but as 24 out of 39 genera do not possess all these three characters in combination, but recede more or less decidedly from the type in the direction of true Liliaceæ, it seems injudicious to follow those who have proposed to keep up Colchicaceæ or Melanthaceæ as a distinct natural order. Mr. Baker defines seven tribes, Colchiceæ, Merenderæ, Veratreæ, Anguillareæ, Helonieæ, Uvularieæ, and Tofieldieæ. There are several anomalous genera of the Colchicaceæ, for instance Hewardia, which connects the Liliaceæ with the Iridaceæ. Again, there are three aberrant tribes of Liliaceæ, viz., (1) Conantheræ a connecting link between Liliaceæ and Amaryllidaceæ, (2) Liriopeæ

(formerly Ophiogon) and (3) Gilliesieæ; genera among the two latter receding widely from the liliaceous type and others bridging over the interval between the extreme form and ordinary lilies. The author then enters into lengthened descriptions with ample diagnosis, &c., forming in fact a valuable continuation of his former series of monographs of the natural order of Liliaceæ. —Messrs. G. Brook, A. P. Luff, J. E. Griffiths, C. Sharp, and J. Woodland, were balloted for and elected Fellows of the Society.

Anthropological Institute, January 28.—Anniversary Meeting.—Mr. John Evans, D.C.L., F.R.S., president, in the chair.—The election of Mr. A. H. Keane, B.A., as a Member was announced.—The following gentlemen were elected to serve as officers and council for the year 1879. President—E. B. Tylor, F.R.S. Vice-Presidents — Hyde Clarke, J. Evans, F.R.S., Prof. Flower, F.R.S., Maj-Gen. A. Lane Fox, F.R.S., Francis Galton, F.R.S., Prof. Rolleston, F.R.S. Directors and Hon. Secretaries.—E. W. Brabrook, F.S.A., W. L. Distant, J. E. Price, F.S.A. Treasurer—F. G. H. Price, Esq., F.R.G.S. Council—Lt.-Col. Goodwin Austen, J. Beddoe, F.R.S., Prof. George Busk, F.R.S., C. H. E. Carmichael, M.A., J. Barnard Davis, Esq., F.R.S., W. Boyd Dawkins, F.R.S., Capt. Harold Dillon, F.S.A., A. W. Franks, Esq., F.R.S., J. Park Harrison, M.A., Prof. Huxley, F.R.S., A. L. Lewis, Sir J. Lubbock, Bart., M.P., R. Biddulph Martin, F. W. Rudler, F.G.S., C. R. Des Ruffières, F.R.S.L., Lord Arthur Russell, M.P., Rev. Prof. Sayce, M.R.A.S., Dr. Allen Thomson, F.R.S., C. Staniland Wake, M. J. Walhouse, F.R.A.S. The retiring president delivered his annual address, in the course of which he alluded to the researches now being carried on in the caves of Borneo by Mr. Everett (see p. 352).

Geological Society, January 22.—Henry Clifton Sorby, F.R.S., president, in the chair.—John Edward Marr and Lieut. Henry Tryon Wing were elected Fellows of the Society.—The following communications were read:—On community of structure in rocks of dissimilar origin, by Frank Rutley.—Distribution of the serpentine and associated rocks, with their metallic ores, in Newfoundland, by Alexander Murray.

Institution of Civil Engineers, February 11.—Mr. W. H. Barlow, F.R.S., vice-president, in the chair.—The following papers were read:—On the Geelong water supply, Victoria, Australia, by Mr. Edward Dobson, Assoc. Inst., C.E.—On the Sandhurst Water Supply, Victoria, Australia, by Mr. Joseph Brady, M. Inst. C.E.

Victoria (Philosophical) Institute, February 3.—A paper on the Torquay caves was read by Mr. J. E. Howard, F.R.S., in which he reviewed the reports given by geologists who had excavated and examined the various deposits in these caves. Mr. Howard examined into the nature of these deposits and the conditions under which they must have taken place, and pointed out the peculiar nature of the evidence by which it was possible to arrive at some conclusion as to the age of those deposits. Prof. Challis, F.R.S., and others took part in the discussion, either by sending communications to be read or by attending to do so.

PARIS

Academy of Sciences, February 3.—M. Daubrée in the chair.—The following papers were read:—Remarks on the third reply of M. Pasteur, by M. Berthelot.—On the development of the perturbative function, &c. (continued), by M. Tisserand.—On the fermentation of cellulose, by M. van Tieghem. The author gives observations on amylobacter, the figured ferment of cellulose. It affects different plant tissues differently; only in the young state have all the cells of all plants their membranes equally dissolved by it. The results have a physiological bearing (digestibility of cellulose from different plants), and a palæontological (unequal chances of fossilisation of different plants). The amylobacter first transforms soluble starch into dextrine, then into glucose, and it is really the glucose that ferments. It seems to be by direct contact of amylobacter with cellulose that the latter is dissolved, not through a diastase of cellulose acting without at a distance.—On the construction of the international geodetic scale, by MM. Sainte-Claire Deville and Mascart.—An account of the physical and chemical properties of the scale (of iridised platinum) prepared by Johnston and Matthey, and of experiments to determine the coefficient of dilatation of a thermometric tube made of the material.—On the invention of several arrangements of the heliometer, by M. De la Gourmerie. He attributes the half objectives not to Dollond but to Bouguer, considered the original inventor of the heliometer.—M. Cosson called attention to a case of fire in the laboratory of his herbarium, arising from carbonisation of boards of flooring exposed to hot air from an air-hole fed from a stove 4 m. off on the floor below.—M. de Lesseps presented a fourth volume of his "Letters, Journal, and Documents to serve for the History of the Suez Canal." He quoted a long letter he had addressed to Mr. Layard, vindicating the enterprise against opposition then offered.—M. Lalanne was elected Free Member in room of the late M. Bienaymé.—On the conditions of existence of a determinate number of roots common to two given equations, by M. Simonnet.—On some invariants of linear differential equations, by M. Laguerre.—On the motion of a body which is displaced and deformed while remaining homothetic with itself, by M. Fouret.—Integration, in finite form, of three species of linear differential equations with any coefficients, by M. André.—Extension of the metric system of weights and measures; development of concordant monetary systems in the various states of the civilised world, by M. de Malarce. The metric system of weights and measures is now established obligatorily in eighteen states, with 236·6 millions of inhabitants; it is legally optional in three states with 75·5 millions; and it is admitted in principle, or partially for customs, in five states, with 343·6 millions.—Liquefaction of siliciated hydrogen, by M. Ogier. It is liquid at $-11°$ under 50 atm.; at $-1°$ under 100 atm. At zero it remains gaseous up to 150 and 200 atm.—Memoir on the determination of methylic alcohol in commercial methylenes, by MM. Bardy and Bordet.—Influence of duration and intensity on luminous perception, by MM. Richet and Breguet. A weak light, perceived distinctly when it impresses the retina some time, becomes invisible when its duration diminishes. It may be rendered visible anew by making it more intense, or increasing its duration, or repeating it rapidly. Coloured lights are subject to the same laws, and are always seen with their proper coloration, whether strong or weak, long or short.—On the minute structure of the central nervous system of decapod crustaceans, by M. Yung.—On the Wagnerite of Bamle in Norway, and on a retinite of Russia, by M. Pisani.—The glazed frost of January, 1879, by M. Godefroy.—On the effects of the same at Fontainebleau, by M. Piebourg. This (somewhat rare) phenomenon did great mischief to trees, the greatly increased weight breaking down their branches, &c.

GÖTTINGEN

Royal Academy of Sciences, November 2, 1878.—The following, among other papers, were read:—On a propagation of the growth-stimulus produced by fertilisation on vegetative organs, by Herr Reinke.—Observations on the value of a ligature of the great brain-arteries, for experimental pharmacological researches, by Herr Marmé.

CONTENTS

	PAGE
THE "THUNDERER" EXPLOSION	333
CAPTAIN COOK	334
THE SAMOAN LANGUAGE. By A. H. KEANE	335
COAL AND IRON. By J. MARSHALL	336
OUR BOOK SHELF:—	
Lockwood's "Natural History, Sport, and Travel"	337
LETTERS TO THE EDITOR:—	
Weather, Past and to Come.—Prof. PIAZZI SMYTH	338
Sun-Spots and the Plague.—Prof. W. STANLEY JEVONS, F.R.S.	338
On the Combustion of Different Kinds of Fuel.—JOHN A. CHURCH	339
Internal Resistance.—Lieut.-Commander C. F. GOODRICH (*With Illustration*)	339
The Formation of Mountains.—Rev. O. FISHER	339
Concerning the Colour of Eyes.—J. M. H.	340
Intellect in Brutes.—HENRY T. FINCK	340
Ear Affection.—Dr. G. L. WALLICH	340
Bees' Stings.—W. RADFORD	340
Electric Lighting.—H. J. NICOLL	340
RELATION OF METEORITES TO COMETS, II. By Prof. H. A. NEWTON	340
METEOROLOGICAL STATION ON BEN NEVIS	342
RESEARCH UNDER DIFFICULTIES. By Prof. E. RAY LANKESTER, F.R.S.	342
ON THE RECENT ERUPTION AND PRESENT CONDITION OF VESUVIUS. By G. F. RODWELL (*With Illustration*)	343
POPULAR NATURAL HISTORY (*With Illustrations*)	345
THE KEITH MEDAL OF THE ROYAL SOCIETY OF EDINBURGH	346
OUR ASTRONOMICAL COLUMN:—	
Tempel's Comet, 1867, II.	347
The Intra-Mercurial Planet Question	347
GEOGRAPHICAL NOTES	348
NOTES	349
OXYGEN IN THE SUN	352
UNIVERSITY AND EDUCATIONAL INTELLIGENCE	353
SCIENTIFIC SERIALS	354
SOCIETIES AND ACADEMIES	354